The History of Air Force Civil Engineers

1907-2012

LEADING THE WAY:

THE HISTORY OF AIR FORCE CIVIL ENGINEERS

1907-2012

LEADING THE WAY

THE HISTORY OF AIR FORCE CIVIL ENGINEERS

1907-2012

RONALD B. HARTZER
LOIS E. WALKER
AND
REBECCA GATEWOOD
KATHERINE GRANDINE
KATHRYN M. KURANDA
OF
R. CHRISTOPHER GOODWIN & ASSOCIATES, INC.

To the Air Force Civil Engineers who have Led the Way

CONTENTS

ILLUSTRATIONS

Figures

Tables

Photographs

Unless otherwise noted, all photos are official Department of Defense photos.

FOREWORD

In 1941, Gen. Henry H. "Hap" Arnold said "Air bases are a determining factor in the success of air operations. The two-legged stool of men and planes would topple over without this equally important third leg." His prescient insight has not changed over the years. But bases don't just appear out of thin air, they have to be planned, built, operated, maintained, recovered and divested. That is the mission of Air Force Civil Engineers, who contribute to airpower by working behind the scenes to provide that "equally important third leg." From dirt airstrips to sophisticated cyberspace facilities, bases have transformed over time to reflect changing technology and threats. Air Force Civil Engineers have also changed their tools, equipment, vehicles, materials, and organizational framework to adapt over time. What has always been unwavering is the commitment of Engineers to the mission, hard work and excellence.

This year we commemorate the 50th anniversary of the Prime BEEF program, the cornerstone of Air Force Civil Engineers' wartime mission since 1964. Next year, in 2015, we will also celebrate RED HORSE's golden anniversary. Over the past half century, the Prime BEEF bull and the RED HORSE have become widely recognized symbols of excellence in agile combat support around the world. From Vietnam to Afghanistan, Air Force Civil Engineers have proudly worn these patches that represent the tradition of service built by their predecessors.

The hundreds of thousands of men and women who have gone before us and served as Post Engineers, Aviation Engineers, Air Installation Officers, Installation Engineers, Civil Engineers, Prime BEEF or RED HORSE have paved the way for each one of us who serve today or in the years to come. We can learn from their experiences and be proud of their remarkable achievements. We owe a great debt to them and honor their service. Each is an integral part of our past and guides us in the future as we continue to "Lead the Way!"

Tim Green

TIMOTHY S. GREEN, Brig Gen, USAF
Director of Civil Engineers
DCS/Logistics, Installations & Mission Support

PREFACE

This book has been nearly 30 years in the making. In October 1985, Maj. Gen. Clifton D. "Duke" Wright, Jr., the Director of Engineering and Services, met with Dr. Ronald B. Hartzer in his Pentagon office. Dr. Hartzer was about to assume his position as the first-ever Historian for Air Force Engineering and Services. General Wright, who had the foresight to capture the past before it disappeared, said one of his goals for Dr. Hartzer was to produce a book-length history of the career field. Dr. Hartzer began collecting historical documents, photos, videos, and oral histories from hundreds of sources. Soon a collection that began with just two folders grew to thousands of documents, many of which were used for this book. The Civil Engineer archives contains the fascinating account of the countless men and women who contributed to the proud history of Air Force Engineering and Services. This book tells their story and fulfills a promise made to General Wright back in October 1985.

The U.S. Air Force was recognized as a separate U.S. Armed Service in 1947, thus fulfilling the vision advanced by many military aviators since World War I. Civil engineering was recognized as a professional discipline critical to the success of the new Service.

Engineers claim a long and proud tradition of military service. During World War II, the U.S. Army Corps of Engineers executed the construction of overseas airfields and support facilities for the Army Air Forces, often under challenging conditions and with meager resources. These successes impressed leaders of the Army Air Forces with the critical importance of civil engineering in supporting Air missions through planning, operating, and maintaining air bases. Many leaders in the early days of Air Force Civil Engineering began their careers with the U.S. Army Corps of Engineers. These leaders were eager to shape the Air Force of the future and to integrate civil engineering into the overall mission.

This history is the story of the Air Force Civil Engineer organization as it grew, matured, and changed in response to mission requirements. Data were compiled from non-classified sources. The chapters are organized chronologically. Chapter 1 presents an overview of the early history of aviation from 1907 through the end of World War II. Subsequent chapters explore the development of the organization in sequential 10 to 15-year time periods. Reoccurring themes and activities in Air Force Civil Engineering common to each period were identified through the archival record and formed organizational framework for the chapters. These themes are civil engineering programs and policies, managing the air bases, construction, education and training, and deployments.

During the 1950s, Air Force civil engineers focused on establishing their place and profession within the newly independent Air Force. They planned, programmed, and oversaw major construction programs to establish a network of air bases in both CONUS and overseas. The air bases that they constructed and managed were comparable to small cities where the base civil engineer administered housing areas, operational areas, fire protection, and utilities. Policies and procedures for effective management and maintenance of the permanent bases were established during this time. Air Force civil engineers also were involved in planning and programming the construction of additional installations to support U.S. defense programs, such as specialized communications posts in the Arctic and missile sites to defend the United States. Educational programs were established to foster professional development for civil engineering personnel to maintain a high-level of personnel proficiency in an ever changing, technically challenging environment. A significant responsibility for Air Force civil engineers was supporting Airmen during times of war or other deployments. During World War II, U.S. Army Corps of Engineers built the landing fields required throughout Europe and Asia, and this function remained with the U.S. Army Corps of Engineers during the 1950s.

Subsequent decades presented continuing challenges and opportunities as the Air Force civil engineer organization responded to national defense priorities and to changing Air Force missions. Air Force civil engineers found themselves with increasing responsibilities to operate and to maintain the large Air Force portfolio of facilities and real property, and to oversee construction of new buildings and structures required to beddown new weapons systems. Often, these missions were accomplished within manpower and budget constraints. To accomplish this complex task, Air Force civil engineers continuously re-invented, re-invigorated, and transformed their organization to maintain focus on critical support to the Air Force mission. Talented and innovative leaders were encouraged at all levels of the Air Force civil engineer organization to identify ways to execute civil engineering responsibilities more effectively. Air Force civil engineer leaders often adapted project and personnel management strategies and business models from the private sector and industry to ensure efficiencies at all levels of their organization. Education and professional development remained a high priority in developing and maintaining military and civilian capabilities. In addition, Air Force civil engineers continually evaluated past performance to identify "lessons learned" and revised their procedures and policies to improve future performance.

Air Force civil engineers confronted the tension between their peacetime role and their role in supporting the deployed Air Force. During the Vietnam Conflict in the 1960s, this tension was resolved through the development and implementation of the Base Engineer Emergency Force, known as Prime BEEF. The purpose of Prime BEEF was to link every military Air Force civil engineer peacetime job to a defined role in emergency situations and direct combat support. This fundamental change affected all areas of Air Force civil engineering, particularly education and training. Prime BEEF was followed by the establishment of Rapid Engineer Deployable Heavy Operational Repair Squadron, Engineer, or RED HORSE. Prime BEEF and RED HORSE gave Air Force civil engineers the ability to build the bases required in deployed locations and get the job done. "Can Do, Will Do" was the civil engineer motto of the 1960s.

The Vietnam Conflict was followed by a decade of peace with corresponding decreases in military funding. The U.S. military became an all volunteer force. In response, Air Force civil engineers implemented programs to improve the quality of life for Air Force personnel in their working and living environments. Readiness training also became a major focus to keep Air Force civil engineers prepared for deployment. The Readiness Challenge, begun in 1986, fostered competition in training activities. Air Force civil engineers also faced increasing responsibilities in managing the permanent bases. New programs were established to comply with environmental and cultural resources laws, as well programs to reduce pollution and to conserve energy.

Air Force civil engineers reshaped their organization during the 1990s as part of the radical reorganization of the Department of Air Force. The reorganization was prompted by Department of Defense and Federal government directives and initiatives. Overseas deployments for Air Force civil engineers increased dramatically as the United States participated in Operation Desert Shield/Desert Storm and follow-on operations. The lessons learned from Desert Shield/Desert Storm guided the development of the Air Force civil engineer organization throughout the decade. Deployments continued to support actions in Somalia and Bosnia and Kosovo. In addition, deployments for training increased greatly as the civic action program was combined with training activities. As a result, Air Force civil engineers gained valuable experiences in planning and constructing facilities, while improving the lives of civilian populations both in the United States and overseas. Caribbean and Central and South American countries, in particular, were the recipients of new medical clinics, schools, and water supply facilities.

The first decade of the twenty-first century was defined by the terrorist attacks on the United States on September 11, 2001. After that event, Air Force civil engineers were engaged continually in all aspects of the Global War on Terror – in defending the United States and in fighting terrorism in Afghanistan and Iraq. Air Force civil engineers adapted to new roles in the joint Service environment to accomplish U.S. missions. In March 2003, the United States, supported by Great Britain, initiated a military action against Iraq, known as Operation Iraqi Freedom. The initial fighting was over quickly and the United States became involved in an insurgency and nation rebuilding program that ended in December 2011. Air Force civil engineers adapted to new roles in nation building while deployed in overseas missions. Meanwhile, at the U.S. permanent bases, Air Force civil engineers engaged in transforming their organizational structure by adopting policies and procedures to work effectively within funding and manpower limits.

Throughout their history, Air Force civil engineers have demonstrated talent, innovation, and continual adaptation to fulfill their missions effectively. Their accomplishments truly have been impressive. The authors wish to extend their thanks and gratitude to all Air Force civil engineers for their military service. This is their history.

Authors

Dr. Ronald B. Hartzer, Historian at the Air Force Civil Engineer Center (AFCEC), served as overall director for this book. He earned a Doctor of Philosophy degree in History from Indiana University and has been a historian with the Air Force for more than 31 years. He has authored a history of the Wilmington, North Carolina, District of the Corps of Engineers and written more than 50 articles for numerous journals. He led the Gulf War Lessons Learned study for Air Force Engineering and Services and co-authored Civil Engineering's first doctrine manual.

Lois Walker retired from Federal Service in 2007 after completing a 27-year career as a historian and holds an M.A. in American History from Wright State University. While serving at Wright-Patterson Air Force Base, Ohio, she co-authored a widely respected history of the base. She later served at the HQ United States Air Forces in Europe History Office and was instrumental in producing a 50th anniversary publication on the Berlin Airlift. She served as Historian at the Air Force Civil Engineer Support Agency from 1998 to 2007.

R. Christopher Goodwin & Associates, Inc., completed this project between 2008 and 2012 on behalf of the Air Force Civil Engineering Support Agency under a contract administered by Air Force Center for Engineering and the Environment through the United States Army Medical Research Acquisition Activity. R. Christopher Goodwin & Associates, Inc., is an award winning cultural resources management group with a national practice specializing in the full spectrum of historic preservation disciplines.

Kathryn M. Kuranda is the Senior Vice-President of Architectural and Historical Services for R. Christopher Goodwin & Associates, Inc, and served as editor for the book. She holds a Bachelor of Arts degree in American Studies from Dickinson College and a Master of Architectural History degree from the University of Virginia. She has directed numerous architectural and historical research projects and nationwide cultural heritage studies, including historic contexts for military properties from all the U.S. Armed Services.

Rebecca Gatewood obtained a Master of Historic Preservation through the University of Kentucky, College of Design. She has been professionally active in the field of historic preservation since the late 1990s. She has extensive experience in historical research and writing, survey, and cultural resource investigations to support a variety of clients nationwide. She has particular experience in conducting historical research and documenting resources for the United States Army, the United States Navy, the United States Air Force, and the Air National Guard. She currently serves as an architectural historian for R. Christopher Goodwin & Associates, Inc.

Katherine Grandine received a Master of Arts degree in American Civilization with Emphasis on Historic Preservation from the George Washington University, Washington, D.C. She has a Bachelor of Arts, History and Geography from the University of Delaware. She has extensive experience in conducting archival and historical research and writing to document cultural resources with a particular expertise in researching and documenting Army, Air Force, and Navy installations in the United States. She currently serves as a senior historian with R. Christopher Goodwin & Associates, Inc.

Additional Contributing Authors

Melissa Crosby has a Master of Arts in Historic Preservation from the Savannah College of Art and Design in Savannah, Georgia. She has a Bachelor of Arts in History from Shepherd University in Shepherdstown, West Virginia. She is experienced in historical research and technical report writing.

Dean Doerrfeld has a Master of Arts in Urban Affairs and Public Policy with specialization in Historic Preservation Policy and Planning from the College of Urban Affairs and Public Policy, University of Delaware in Newark, Delaware. He has a Bachelor of Liberal Studies (with distinction) with a specialization in Historic Preservation from Mary Washington College, Fredericksburg, Virginia.

Christine Heidenrich, received a Master of Arts degree in Public History from Loyola University Chicago, and a Bachelor of Arts degree in History from University of Illinois at Urbana-Champaign. She has extensive experience in conducting historical research and writing on historical topics.

CHAPTER 1

LAYING THE FOUNDATION
1907-1947

For as long as there have been military airfields, there have been military engineers dedicated to their design, construction, operation, maintenance and repair. Before the United States Air Force became a separate service in 1947, construction personnel working with the Army Quartermaster Corps and engineers assigned to the U.S. Army Corps of Engineers worked closely with the Air Service, the Army Air Corps and, eventually, the Army Air Forces. Although not aviators themselves, these military personnel formed a dedicated cadre of experts knowledgeable in the construction of airfields and associated facilities critical to supporting flying operations. This knowledge became particularly critical in times of war when military engineers were tasked to construct, on short notice, airfields in war zones to support critical missions. By World War II, this specialty branch of engineering was known as aviation engineering and became the basis for the civil engineering function that evolved when the Air Force became a separate service in 1947.

The history of Air Force civil engineering is incomplete without a discussion of the early evolution of U.S. military aviation. This chapter explores this early history during the period from the initial creation of a U.S. aviation function in 1907 through World War II. This period laid the foundation for the creation of the U.S. Air Force and was crucial in the evolution of civil engineering as an aviation function.

THE ARMY TAKES WING

The first U.S. government aviation function was established on August 1, 1907, when an Aeronautical Division was created within the Army Signal Corps. The Division was given charge of "all matters pertaining to military ballooning, air machines, and all kindred subjects." Construction related to aviation was managed by the Office of the Chief Signal Officer. The Army purchased its first heavier-than-air flying machine, designated Signal Corps Airplane No. 1, from Wilbur and Orville

Orville Wright flying a Signal Corps Flyer at Fort Myer, June 1909.

The Aviation School at College Park was always busy with visitors dressed in their best clothing coming to see the aeros up close. (Courtesy of College Park Aviation Museum)

Wright on August, 2 1909. Endurance and speed tests for the aircraft were conducted on the narrow drill ground at Fort Myer, Virginia. Fort Myer was the first of a series of Army posts that granted the Signal Corps temporary permission to use their parade grounds as makeshift airfields to support the new and unusual mission.[1]

The first land leased by the Army Quartermaster specifically for a flying field was a tract owned by the Maryland Agricultural College at College Park, Maryland, seven miles north of Washington, D.C. The site was accessible by road but, more importantly, was situated on the Baltimore & Ohio railroad line. The location was advantageous since early aircraft typically were disassembled and shipped by rail. The Wright brothers instructed the world's first military pilots at College Park. Lts. Frank Lahm, Benjamin Foulois and Frederic Humphreys received pilot training in the operation of the Army's first aircraft in October and November 1909. The College Park flying field was short-lived since the military held a temporary lease.[2]

In 1910, Lieutenants Lahm and Humphreys returned to duty at their respective branches of the Army (the Cavalry and the U.S. Army Corps of Engineers). Lt. Benjamin Foulois served as the Army's only active pilot, flying from Fort Sam Houston, Texas, in Signal Corps Airplane Number One.[3] He and his detachment erected a small hangar on the drill ground. Although modest, this temporary airdrome established San Antonio as a military flying center. Fort Sam Houston served as the Signal Corps' sole airfield for the next year and a half. In April 1911, three more officers joined Lieutenant Foulois to form the Provisional Aero Company. They built a second hangar and operated the Army's fleet of six aircraft (five Wright Model Bs and one Curtiss IV Model D). On May 11, 1911, Lt. George Kelly—for whom Kelly Field was subsequently named—crashed on landing and died when he was thrown from his plane. The commanding general at Fort Sam Houston banned further flying. The pilots and aircraft were forced to move in July, although the two hangars remained at the site.

Airdrome (âr´drōm): General term for a military airfield, consisting of a landing and take-off area for aircraft and facilities for the servicing, maintenance, and administration of the units there stationed.

SUPPORT FOR THE TRAINING MISSION

Meanwhile, the Signal Corps recognized the need for a permanent facility dedicated to pilot training. On March 3, 1911, Congress authorized the first appropriation for Army aeronautics in the amount of $125,000 for fiscal year 1912. Most of the money was used to purchase aircraft, but some was spent on facilities. The Signal Corps decided to return to the College Park site and to construct expanded training facilities. The Quartermaster Department, historically responsible for construction and supply to support the U.S. Army, executed a land lease for the tract used in 1909 and an additional 200 acres for a monthly rent of $325. The Quartermaster Department cleared the land and constructed four wood-frame hangars. Lt. Col. Charles deForest Chandler, Officer in Charge of the Signal Corps Aeronautical Division, served as commandant of what became known as the Signal Corps Aviation School. The school operated at College Park during warm weather and moved operations to Augusta, Georgia, during the winter months.[4]

One of the school's more famous students in 1912 was Lt. Henry H. "Hap" Arnold, future commanding general of the Army Air Forces in World War II. He described the school's facilities as comprising the hangars near the B&O railroad tracks, a small administration building and an emergency hospital tent, which was manned by Lt. John P. Kelley, recognized as the first Flight Surgeon. By the end of 1912, the school boasted 8 hangars, 14 flying officers, 39 enlisted men, and 1 civilian mechanic. In addition to experimenting with aerial photography and aerial gunnery, students devised the first airfield lighting system. Acetylene signal lamps were set up along the landing strip to enable experiments in night flying.[5]

In fall 1912, aviation pioneer Glenn Curtiss, who also sold airplanes to the Army, invited the Signal Corps to send officers to his private flying school in San Diego, California, for winter flying. The Signal Corps accepted the invitation and divided the winter assignments for Aviation School by airplane type. The pilots and mechanics assigned to Wright airplanes returned to Augusta, Georgia, while the Curtiss pilots and mechanics were sent to North Island in San Diego. The school at College Park closed on November 18, 1912 and did not reopen. Although legislation to purchase the property was introduced, the Chief Signal Officer recommended against renewing the lease when it expired in June 1913.[6]

San Diego offered near perfect flying conditions and became home to the Army's first permanent aviation school. Five lieutenants and a detachment of eight enlisted men arrived for duty in November 1912. The Army paid Curtiss 25 dollars a month for use of his school and hangar space. The Signal Corps' quarters consisted of an old barn and a shed. The school staff eventually erected a canvas hangar to house its three aircraft.

In 1913 the Signal Corps discontinued the agreement with Glenn Curtiss and negotiated directly with the owner of North Island, the Coronado Beach Company, for use of a new camp independent from the Curtiss school. Negotiations were successful and the school grew with construction assistance provided by the Quartermaster Corps. In December 1913, the country's first military flying unit, the First Aero Squadron, was organized at North Island by War Department General Order No. 75. By June 1915, squadron strength stood at 30 officers, 12 civilians, and 185 enlisted men; the squadron maintained an inventory of 13 airplanes. Military aviation was here to stay.[7]

Site improvements supported the training mission. In addition to runway work to support pilot training, construction of several more hangars allowed the school to offer technical courses in the maintenance, repair, and operation of aircraft and engines. A notable innovation developed at North Island was a portable field tent hangar for use during exercises and operations. The Army continued to lease the North Island property through World War I. In July 1919, Congress authorized $6 million to purchase North Island, then known as Rockwell Field.[8]

EARLY AIRFIELD SITES

Utilization of a site selection board to make informed decisions on the location for the permanent school established an important precedent. The Army Appropriation Act of 1915 directed the Secretary of War to appoint a commission to investigate land acquisition on the Pacific, Gulf, or Atlantic coasts for an aviation school. Col. Samuel Reber of the Signal Corps and Capt. Richard Marshall of the Quartermaster Corps visited numerous potential sites on the east and west coasts in search of those that met the stringent criteria for flying. These criteria included obstruction-free acreage to accommodate the flying field, favorable weather and wind conditions, regular topography, access to utilities and transportation, and a cordial relationship with surrounding communities. Colonel Reber and Captain Marshall worked with local chambers of commerce to arrange public meetings to solicit sites for consideration. The experience gained through this process was applied in the development of guidelines and procedures for future selection boards.[9]

Meanwhile, the Signal Corps established its first overseas air station, which was charged primarily with conducting reconnaissance missions. In December 1911, the Chief Signal Officer shipped a Wright B airplane with enough spare parts for six months to the Philippines. The Quartermaster in Manila built a two-plane hangar on the edge of the polo field at Fort William McKinley to support the air station. The hangar, complete with a concrete floor, was the first of its kind and cost $1,809.91 to construct. Lt. Frank Lahm, then with the 7th Cavalry, was detailed to temporary duty in aviation with the Signal Corps and opened the Philippine Air School in March 1912. The school operated sporadically until January 1915. Another overseas aviation station also was established briefly in Hawaii between 1913 and 1914. The Hawaii station included tents for housing, temporary wood-frame airplane sheds, and a rudimentary machine shop.[10]

Interestingly, several National Guard units, most notably in the states of New York, Missouri, and California, formed aviation detachments. The units purchased their aircraft or in some cases, aviation-minded philanthropists donated aircraft to the units. Each unit operated on its own initiative in training and in the construction of facilities to support their airplanes. The Signal Corps Aviation School at North Island eventually admitted a limited number of National Guard pilots beginning in 1916.[11]

FACILITIES FOR THE FIRST OPERATIONAL UNITS

On July 18, 1914, the Army's existing air wing received official sanction when Congress authorized a separate Aviation Section within the Signal Corps. Although some argued that aviation should be reassigned elsewhere, proponents for organizing the Aviation Section under the Signal Corps prevailed. Authorization of the Aviation Section gave the fledgling function official recognition and its first definite status. Previously, aeronautics was not among the official duties tasked to the Signal Corps.[12]

The Chief Signal Officer in 1914, Brig. Gen. George Scriven, promoted the establishment of an operational aviation center separate from the aviation school at North Island. He sought to avoid potential conflicts between operational and training units arising from shared funding and infrastructure. The principal criteria for selecting a site for the proposed operational center were favorable flying weather, an established troop presence, and available government land. The logical location was an old target range located four miles north of Fort Sam Houston, Texas.[13]

Lieutenant Foulois traveled to Fort Sam Houston to prepare plans and estimates for roads and buildings. Enlisted men assigned to First Aero Squadron hauled supplies from Fort Sam Houston to the site and worked for six months to build roads, walks, and drains, and to prepare the landing field. They constructed two hangars, each accommodating five planes. Lieutenant Foulois secured authorization to relocate the two old hangars from the drill ground at Fort Sam Houston to the new site.[14]

In November 1915, the First Aero Squadron officially moved from San Diego to San Antonio.

A bird's-eye view of the aviation post at Fort Sam Houston, Texas.

The squadron soon was ordered to Columbus, New Mexico, to join Brig. Gen. John J. Pershing in his pursuit of Pancho Villa on the Mexican border. This assignment presented the first opportunity for an Army aviation unit to operate under field conditions over a large area. The squadron made a total of 548 flights in the United States and Mexico.[15]

In his after-action report, then-Major Foulois identified one of the primary factors distinguishing air operations from ground operations. While missions are conducted in the air, aircraft must eventually land and thus are dependent on fixed bases. He opined that "one or more aero squadrons, operating in the field should have a base, conveniently located, from which all supplies, material, and personnel should be drawn."[16] He envisioned a base capable of both supplying and receiving, with a maintenance capacity for testing and for building engines using materials gathered from around the country. Major Foulois's vision for dedicated aircraft facilities is obvious in hindsight. He was one of the first to encourage and to promote fixed bases devoted to aircraft support. In his 1968 memoirs, published posthumously, General Foulois described his view on the future of aviation,[17]

> I gave vent to my conviction that action had to be taken swiftly for the sake of American air power. I pointed out in great detail the immediate and general needs of the Aviation service of the Army and recommended reorganization of the Washington office of the Aviation Section, legislation for more efficient use of appropriations then available, a survey of all military posts to determine their use as flying schools and air stations, and legislation which would lead to the establishment of a flying corps, separate and distinct from any other corps or branches of service.[18]

Specifications for Army aircraft were becoming steadily more rigorous and the airplanes delivered over the next several years became more powerful and complex. The facilities to support aircraft needed to match the sophistication of the aircraft.[19]

Three more flying units were activated in the San Antonio area—the 3d, 4th, and 5th Aero Squadrons. Additional units required new and expanded facilities, a common challenge at each aviation outpost. By 1916, the 2d Aero Squadron, located in the Philippines, operated one company of aircraft modified as seaplanes and was preparing to add a second. The 6th Aero Squadron was organized near Fort Kamehameha in Honolulu, Hawaii. Capt. John Curry deployed to the islands in January 1917 and selected a site on Ford Island in Pearl Harbor for a seaplane base. The site was purchased for

$235,000. The 7th Aero Squadron organized by Capt. Hap Arnold was established in Panama in January 1917. All of these activities required construction support. The Chief Signal officer requested that the Quartermaster General fold funding for barracks for San Antonio and barracks, officer quarters, a machine shop, and a storehouse for each of the overseas stations into his 1917 budget estimates.[20]

ESTABLISHING INFRASTRUCTURE FOR WORLD WAR I

Despite significant progress, U.S. military aviation was still in its formative stages when World War I broke out in Europe. Great Britain, France, Germany, and Italy were more advanced and visionary than the United States in exploiting the military potential of the airplane. U.S. aviation strength compared very poorly to the pre-war strengths of the major European powers. Based on the performance of the 1st Aero Squadron during Pershing's expedition against Pancho Villa, Congress appropriated an additional $500,000 for military aeronautics, a paltry sum compared to the $45 million that Germany appropriated for military aeronautics in its last pre-war budget. In August 1916, Congress moved to correct this inequity and allocated nearly $14 million for military aeronautics. An additional $600,000 also was approved to purchase land for aviation sites in anticipation of U.S. involvement in the European War. For the first time, the Signal Corps had money to develop aviation and launched a nationwide search to find suitable sites.[21] Land for four important Army flying fields was acquired in late 1916: Kelly Field near San Antonio, Texas; a New York National Guard site on Long Island which included Mitchel Field; Ford Island Naval Reservation in Hawaii; and a field on the lower Chesapeake Bay near Hampton, Virginia.[22]

In Hampton, Virginia, the War Department purchased 700 acres of land at a cost of $490,000 to establish an experimental station that became Langley Field. While many sites previously were leased, the Virginia land acquisition represented the first time that the government purchased land specifically for an air installation.[23] The general locale near Hampton was identified as suitable, but site work and the construction of quarters and technical structures proved more difficult than anticipated. The Quartermaster Corps retained noted architect and industrial planner Albert Kahn to design the major buildings and general layout of the field. The United States entered World War I only five months after the land was purchased. Once war was declared, the civilian construction contractor working at Langley was given urgent orders to increase his work force and to accelerate operations. The pressure to expedite work led to confusion and inefficiency. Construction actually slowed and Langley played only a limited role in World War I. The Navy, which was partnering in the endeavor, grew impatient

An aerial view of Langley Field, 1918.

and moved its operations to experimental bases elsewhere. The Aviation Section of the Signal Corps decided to pursue a similar course and ultimately constructed a major experimental and test facility at McCook Field in Dayton, Ohio.[24]

THE UNITED STATES ENTERS THE WAR

Despite pre-war preparations, the engineering force and the basing infrastructure required to support the massive wartime buildup were inadequate to meet initial demand. Premier Alexandre Ribot of France requested that the United States provide a staggering 16,500 aircraft, 5,000 trained pilots, and 50,000 mechanics for the first six months of the 1918 campaign. Congress initially appropriated $4.5 million in May 1918 for the purchase and improvement of land and the construction of barracks and technical buildings. In June 1918, a Deficiencies Appropriation Act provided another $9 million to acquire land and to construct buildings and utilities at various aviation facilities. It was not until the July 1918 appropriation of $640 million earmarked for aviation that the construction program truly got underway. Section 9 of Public Law 29 addressed establishing, equipping and operating aviation stations. The law was an omnibus measure covering all aspects of acquisition, procurement, and construction, with no limits on funds that were to be expended in any area. According to historian Dr. Jerold E. Brown, that act, more than any other, "was the platform on which the U.S. aviation program was built."[25]

During the course of the war, the Signal Corps Aviation Division and its successor, the U.S. Air Service, oversaw the development of 33 major training installations, numerous auxiliary flying fields, four aircraft acceptance parks, five aviation supply depots, three aviation repair depots, four balloon fields, and a number of special schools. The names associated with airfields established during World War I would become famous in Air Force history. Chanute Field at Rantoul, Illinois; Selfridge Field at Mount Clements, Michigan; Scott Field at Belleville, Illinois; Kelly Field at San Antonio; and Wilbur Wright Field at Dayton, Ohio, all served admirably during the war. More notably, the airfields survived the interwar period and continued to operate during and after World War II as major Air Force installations. Perhaps the best known engine repair depot was the one established on the infield of the famous Indianapolis Speedway race course. That site was chosen because it was located between Rantoul, Scott, Selfridge, and Wilbur Wright fields and because a landing field, complete with hangar, was offered to the government at no cost.[26]

OVERSIGHT OF THE CONSTRUCTION PROGRAM

Prior to World War I, most construction activity in the U.S. Army was the purview of the Quartermaster Corps through its Construction and Repair Division. As a result of the highly specialized character of aviation buildings, construction of those facilities eventually was assigned to the Construction Division of the Equipment Branch in the Office of the Chief Signal Officer. After war was declared in April 1917, the Construction Division was separated from the Equipment Branch. It reported directly to the Chief Signal Officer and was given an expanded mission that included the preparation of plans for the construction, maintenance, and repair of flying fields required by the Aviation Section.[27]

Still further changes were in store as the war deepened. In October 1917, all emergency construction, including aviation fields, was aligned under the Cantonment Division in the Office of the Quartermaster General. Many believed that construction should be handled by a separate, stand-alone organization. In February 1918, the Cantonment Division was removed from the Office of the Quartermaster General and placed directly under the Chief of Staff of the Army as part of the Operations Division. One month later, in March 1918, the War Department designated the Cantonment Division as a separate branch of the Army and renamed it the Construction Division.[28]

On May 21, 1918, President Woodrow Wilson transferred the Army aviation function from the

Signal Corps to two agencies under the Secretary of War, the Bureau of Aircraft Production and the Division of Military Aeronautics. Together, those two agencies constituted what was known as the U.S. Air Service. The Buildings and Grounds Section, which was commanded by Capt. E. I. Eagle, was part of the supply function in the Department of Military Aeronautics. By January of 1919, the office had a staff of 24 officers, 11 enlisted men, and 19 civilians. Their assigned duty was to “supervise construction and maintenance of all buildings and grounds in the Air Service, both in the United States and its foreign possessions.”[29]

CONSTRUCTION ON THE HOME FRONT

Within a few weeks after the United States entered the war, two Allied commissions visited the U.S. One commission, representing Great Britain, was headed by Arthur J. Balfour and the other, representing France, was headed by Gen. Joseph Joffre and M. Rene Viviana. The commissions advised the War Department on requirements for training facilities and flying fields to support Europe. They also made arrangements for the first ten squadrons of U.S. flyers to be trained at British schools. A reciprocal agreement allowed some U.S. flyers to train at Canadian airfields and Canadian aviators to use fields in the southern United States during the winter.[30]

Lt. Col. Clinton G. Edgar, a reservist called to active duty, was in charge of the Signal Corps Construction Division. A businessman and assistant superintendent of the Detroit gas works, Edgar again called upon fellow Detroiter, architect Albert Kahn, who had developed plans for Langley. Colonel Edgar wanted Kahn to design a basic layout for aviation training fields patterned on a design used in Canada. During a ten-day crash effort, Kahn and Colonel Edgar completed a basic design, created blueprints, and rushed specifications to the various on-site Construction Division supervising officers. The plan for a standard single-unit training field called for 54 buildings to accommodate 100

Wilbur Wright Field, July 1923.

Wilbur Wright Field civilian workers.

aircraft, 150 student pilots, and the training cadre. That design was used for early fields such as Scott and Selfridge, but was later modified to conform to local needs and the availability of materials. The typical flying field built in 1917 cost just over $1 million.[31]

Wilbur Wright Field near Dayton, Ohio, was selected as a training airfield because it was a known quantity. The field served as headquarters for the Wright School of Aviation from 1910-1915. Wilbur Wright Field was programmed as one of the four largest U.S. aviation schools and supported four school squadrons, 24 hangars, 1,700 personnel (including 300 flying cadets), and up to 144 aircraft. Construction was expedited and began on May 25, 1917—a little more than a month after the United States entered the war. The first contingent of flying cadets arrived on July 15.[32]

Due to the urgent need for manpower, construction contractors had to cast a wide net for workers. At Chanute Field, for instance, carpenters and building mechanics were recruited from a 100-mile radius to fill the labor pool. Appropriate vehicles for transporting construction supplies were inadequate at most sites, and farm wagons were employed to haul lumber when suitable transportation was unavailable. Mud was a common bottleneck at many construction sites. It also took extensive efforts to plan for and lay railroad spurs needed to support the new training fields. With construction delays, it was not unusual for squadrons to arrive at the new fields before construction was complete.[33]

Despite difficulties, the construction program resulted in a solid network of ground installations spread primarily along the eastern seaboard, in the Midwest, in the Gulf Coast states, and in southern California. These hastily-built but effective installations allowed the United States to train thousands of pilots and technicians, and to test, repair, overhaul, and outfit large numbers of aircraft.

THE ROLE OF MILITARY ENGINEERS

Although contractors were hired to complete most construction projects in the United States, the use of troop labor did occur. In Texas, for example, troops at Fort Sam Houston awaiting training or transportation aided with construction in the interim. Once facilities were built, the Engineering Department was at the heart of the Signal Corps flying school. “The whole fabric of maintenance and operation of the field” depended on the department.[34] Its main priority was procurement and maintenance of aircraft for the school. The Engineering Department trained airplane engine mechanics, assembled and repaired aircraft, maintained records on aircraft performance, and supplied aircraft with fuel and lubricants.[35] The second priority for the Engineering Department was repair and maintenance of the buildings on post. Much of the workload related to this latter responsibility was precipitated by poor construction workmanship, inferior materials, and expedited construction. Members of the Engineering Department also performed many functions performed by civil engineers today: surveying, drafting, utilities maintenance (electrical, water, and sewage), and road and grounds maintenance.[36]

ENGINEERS "OVER THERE"

On April 6, 1917, the United States declared war on Germany and the U.S. military forces officially entered World War I. The engineering component available for immediate military service numbered only 267 officers and 2,228 enlisted men. At the conclusion of the war, 19 months later, the force claimed 10,886 engineer officers.[37]

The bulk of engineer construction in France involved ports, roads, standard and light railroads, fixed and floating bridges, storage depots, water supply, sewage facilities, remount depots, veterinary hospitals, electrical installations, bakeries, lumbering and forestry operations, and oil and gasoline storage facilities. Brig. Gen. Mason Patrick, an officer in the U.S. Army Corps of Engineers then serving as Chief of Construction and Forestry for the American Expeditionary Forces (AEF), directed all engineer construction, from the smallest to the largest projects.[38]

The Air Service was particularly interested in the construction of airdromes, supply depots, repair shops, barracks, and training centers. In addition, the Air Service required aircraft assembly plants where aircraft, which were delivered to France in sections, were assembled. These plants typically comprised an assembly shed with an adjacent motor testing area, storage sheds, and a salvage shed. The Air Service also needed training centers with landing fields, hangars, repair shops, and accommodations for personnel. Additional landing fields were prepared behind the front lines, which necessitated cutting down weeds and grubbing out sites. Fields were made as level as possible and planted in grass. Plows, scrapers, graders, rollers, and tractors were used when available.[39]

The 462d Aero Squadron was the first Army construction squadron dedicated to performing airfield work for the Air Service overseas. It was formed at Kelly Field as the 48th Provisional Squadron on August 4, 1917, and was converted to a construction squadron three weeks later. The squadron entrained for Mineola, New York, in September, and shipped out for Europe on the Cunard ocean liner *Pannonia* in October, arriving in France on November 1st. For the remainder of November, the squadron, then designated the 435th Aero Squadron, helped build the Third Aviation Instruction Center at Issoudun, the largest flying instruction center in France. They built barracks and shops out of lumber shipped from the U.S. and erected French Bessoneaux hangars for the aircraft, as well as other projects to bring the aerodrome on line. During the stay at Issoudun the squadron number was changed to the 462d Aero Squadron.[40]

In December, the 462d helped build the Second Aviation Instruction Center at Tours and also took on the job of building six fields around the main airfield at Issoudun. At both Issoudun and Tours the squadron got the reputation of being one of the best all-around construction units in the American Expeditionary Force. They performed whatever projects were need, from leveling flying fields and building barracks and roads, to erecting hangars and laying out water systems.[41]

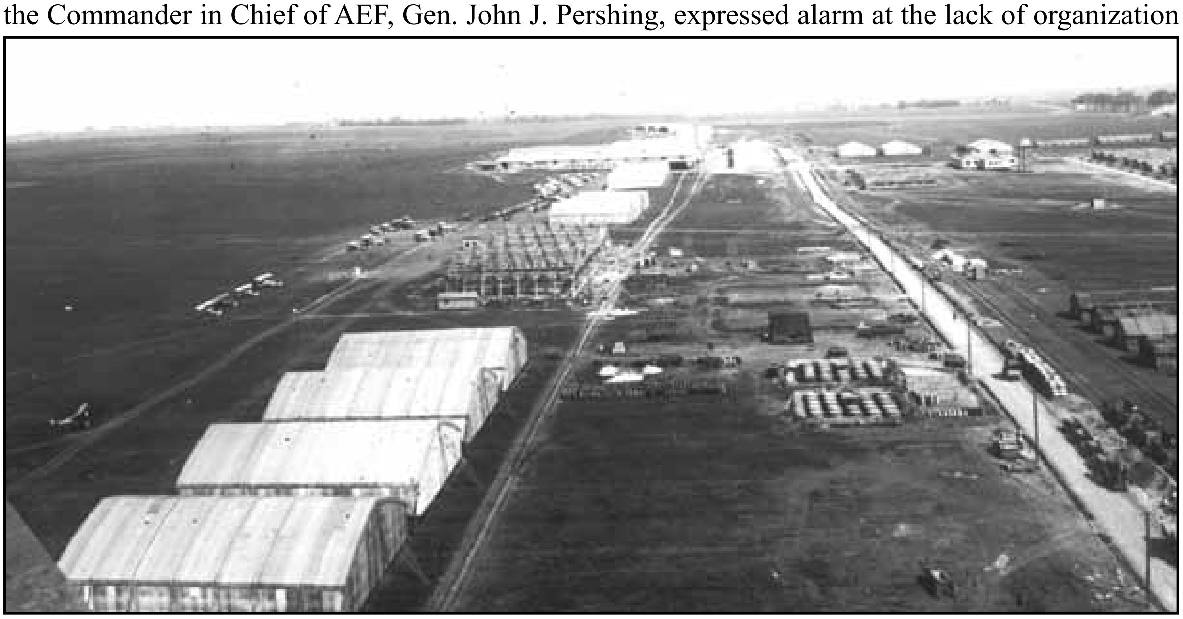
In late April 1918, the squadron was ordered to the Front. At Roseires-en-Haye they helped build the Second Day Bombardment Airdrome, consisting of 27 French barracks, 14 Nissen huts, and 15 Bessoneaux hangars. A force of 200 Moroccan laborers helped level the airfield. In August the squadron was attached to First Army and moved to Vancouleurs to build another airdrome under rushed conditions for the St. Mihiel offensive. In September they erected hangars on the airfields at Vadelaincourt, Feucacourt, and Lisle en Barrois and helped other construction squadrons erect hangars on other fields. The squadron was responsible for trucking hangars from location to location.[42]

In the last two months of the war, the 462d built an airdrome of 12 hangars and 23 barracks at Parois and reconstructed a captured German airdrome. Arriving while the infantry was still on site, they had to wait for the doughboys to move on and then contend with airfields that were full of trenches and shell holes. Following the Armistice, the squadron was attached to Third Army and moved to Treves, where it was tasked to prepare the airfield for seven squadrons, which they did in three days. Upon completion of its work in Europe, the squadron returned to the United States and was inactivated in August 1919. The unit achieved a number of "firsts" in its short existence. The 462d Aero Squadron was the first construction squadron formed for overseas duty, the first to land in England and France; the first to reconstruct a captured German airdrome, and the first Air Service unit to enter Germany.[43]

The 462d and at least one other American construction aero squadron performed the same types of heavy construction and repair work that their successors, the aviation engineer battalions in World War II and RED HORSE squadrons in Vietnam, would perform. They were the earliest examples of construction units dedicated specifically to provide real-time airfields and aviation-specific structures to support combat flying operations. In recognition of their service, AEF General Order No. 29, dated November 21, 1918, stated that the Army Air Service commander of First Army [Brig Gen Billy Mitchell] wished to make a record of his "extreme satisfaction" with the conduct of the 462d. It read: "[The] 462d Aero Construction Squadron during the advance of our troops in the St. Mihiel and Argonne-Meuse offensives constructed five airdromes on the retaken territory with such alacrity as to enable our flying squadrons to carry on operations without delay."[44]

Air Service leaders voiced concerns during World War I, which ultimately were addressed, in part, through the creation of aviation engineer battalions in World War II. Air Service leaders during World War I argued that it was "absolutely vital" that construction materiel, as well as construction personnel, be controlled directly by the Air Service in war zones. They observed that dedicated aviation forces were needed to prepare airfields and to relocate buildings from one airdrome to the next without the added delay of seeking authority from engineers further up the chain of command. When engineers were not dedicated to airfield construction, they often were out constructing other military requirements, such as bridges or roads, just when they were needed to support the Air Service. In those instances, non-specialized troops assigned to all skills in the Air Service often were pressed into service to accomplish these tasks.[45]

Maj. Gen. Mason Patrick, who was in charge of all construction for the AEF, eventually was called upon to apply his engineering acumen for the sole benefit of the Air Service. By May 1918, the Commander in Chief of AEF, Gen. John J. Pershing, expressed alarm at the lack of organization



Aviation Field #3, Issoudun, France.

within the aviation corps in Europe. Nearly 35,000 Air Service troops were in France, England, and Italy; another 35,000 were anticipated to arrive in France before the end of 1918. No coordinated plans existed for housing, equipping, and organizing Air Service men and their aircraft into flying squadrons. In addition, no provisions were made for support units, such as repair depots.[46]

General Pershing appointed General Patrick as Chief of the Air Service for the AEF and directed him to apply a solid engineering approach to the problem. General Patrick reorganized the structure of the Air Service overseas. He realigned the plan for managing, supplying, and transporting Air Service troops in theater and placed all operations on an efficient working basis. As the number of U.S. air units increased, General Patrick placed them along the French front under the Air Service, First Army. The units were organized into three wings—pursuit, observation, and bombardment. The new organization and the improved conditions at field bases contributed to the air superiority of the Allies and to ultimate victory.[47]

General Patrick's success in organizing the Air Service overseas influenced his later career. His last assignment with the U.S. Army Corps of Engineers was as commanding officer of the Engineer School at Camp Humphreys, Virginia. In October 1921, he was selected as chief of the U.S. Air Service in Washington and served in that capacity until December 1927, making major improvements for Airmen everywhere.[48]

SPIN-OFFS OF THE WAR

During World War I, the U.S. Army Corps of Engineers took a keen interest in a unique aviation service, aerial photography. Aerial observation squadrons were responsible for over 18,000 photographs of enemy positions during World War I. Photographic units used these aerial images to produce more than 585,000 prints for war planners and engineers. Civil engineers recognized that aviation would change dramatically the way wars were fought. In a 1920 issue of *The Military Engineer* magazine, one engineer wrote, "Aeroplane photography secured much of the data required for the preparation of new maps, and in my opinion, in future military operations, even in poorly mapped countries, the basic means of securing information for the production of maps will be this agency."[49]

The Society of American Military Engineers (SAME) was a direct result of U.S. military experience during World War I. Following the war, military engineers recognized the pronounced need for such a professional organization. The primary purpose of SAME was "to conserve the teachings of the World War in the field of military engineering and to maintain unimpaired the assets represented by our late experience." The goal of the society, founded in 1920, was to provide a professional resource for those who "in a future national emergency must shoulder the engineering burdens of the country." By the mid-1920s, SAME chapters were active in Boston, New York, Philadelphia, and Washington, D.C. on the east coast; in Chicago, Cincinnati, Milwaukee, Pittsburgh, and St. Louis in the Midwest; and in Portland, Seattle, and San Francisco on the west coast.[50]

DREAMS VERSUS REALITY

Challenges lay ahead for civil engineering in the postwar period. In spring 1919, the Air Service made plans for a moderately-sized aviation force of 24,000 officers and men. A budget request for $60 million was submitted and there was speculation concerning the establishment of a separate Department of Aeronautics. Congress approved approximately a third of the requested funds and the proposed force strength was cut in half. The War Department made it clear that the Air Service would remain part of the Army.

The first task in the postwar period was deciding the disposition of the properties developed to support the war effort. Most leased properties reverted to their original owners. Buildings erected at leased sites were, for the most part, temporary construction and were either abandoned or demolished.

All military equipment was salvaged, sold, or shipped to Air Service depots for storage. Only Rockwell airfield in California and Langley airfield in Virginia had any permanent construction at the end of the war. McCook Field in Dayton, Ohio offered the only hard-surfaced (macadam) runway.

The government opted to purchase 15 World War I installations within eight months of the end of the war and ultimately expanded the acquisition program to include a handful of additional stations. Government owned property included Chanute (Illinois), Fairfield (Ohio), Kelly (Texas), Langley (Virginia), Mather (California), Mitchel (New York), Pope (North Carolina), Rockwell (California), Selfridge (Michigan), and several others, as well as the supply depot at Richmond, Virginia, and the repair depots at Middletown, Pennsylvania and Little Rock, Arkansas. The Air Service also retained McCook Field as its engineering center for research and development for aircraft, engines, and aviation equipment. Flying training was consolidated at Brooks and Kelly in San Antonio, while technical training was centralized at Chanute.

ARMY REORGANIZATION ACT OF 1920

On January 4, 1920, Congress passed the National Defense Act, amending the National Defense Act of June 1916. The Air Service became a combatant arm of the Army, with an authorized strength of 1,516 officers and 16,000 enlisted men. As was true throughout the services, however, assigned strength perpetually remained well below authorized strength until World War II. In 1926, when the Air Service became the Air Corps, the service only had 919 officers and 8,342 enlisted.[51]

Lack of personnel had a direct effect on the number of installations that could be adequately manned and maintained; and postwar budgets did not support operations and maintenance. For FY21, Congress appropriated $3.7 million for the Air Service to maintain 25 stations. The following year, funds for improvements to stations were reduced by 90 percent and that budget continued to decline in subsequent years. In 1928, the budget for improvements to stations was $1 million.[52]

As part of the new organization of the Army, several separate services developed during World War I were eliminated. Among these services were the Construction Service, the Transportation Service, and the Motor Transport Corps. All three services reverted to functions of the Quartermaster Corps. In terms of civil engineering-related work, the Quartermaster Corps was charged with directing all work pertaining to the construction, maintenance, and repair of buildings, structures, and utilities. Local quartermasters also had responsibility for operating utilities on Army posts.

Within the Air Service, oversight of construction and maintenance conducted by the Quartermaster at Air Service stations was still vested in the Buildings and Grounds Section; the section eventually became part of the Property Division of the Supply Group at Air Service headquarters in Washington, D.C. The Buildings and Grounds Section also had responsibility for real estate matters, which was a very time-consuming assignment in the immediate postwar period. The section acted as the Air Service liaison with the Construction Division of the Quartermaster Corps and prepared preliminary data and recommendations for new projects, including design of buildings and utilities.[53]

Despite dismal appropriations and stiff competition for resources among different sections of the Army, morale and enthusiasm was high in the Air Service, mainly due to exciting developments in the world of aviation. New technologies were being developed and tested. New endurance, speed, and distance records were superseded almost as quickly as they were set. The Air Service was challenging and exciting. High-profile pioneers like Brig. Gen. Billy Mitchell, who served as Assistant Chief of the Air Service from 1920 to 1925, ensured that the accomplishments of the Service were visible not only to the War Department leadership and Congress, but to the public as well.

AIR INSTALLATIONS IN THE EARLY 1920S

The story of airfields in the 1920s and 1930s was one marked by constant determination to keep up with technology. Aeronautics was a rapidly-evolving science. Design changes in the size, weight, power, speed, load capacity, and complexity of aircraft kept engineers busy developing facilities to house, operate, and maintain them. In some cases, engineers built hangars and test facilities designed to meet current aeronautical requirements only to have new developments force the immediate modification of those facilities or the construction of new ones.

Construction of World War I facilities tended to be simple and linear. The typical early military airfield featured an open field for take-offs and landings, bordered by a linear development of hangars, warehouses, and other support buildings. In 1923, the Buildings and Grounds Office in Washington developed a general plan for Air Service stations that was described as "an ideal typical layout." The plan made maximum use of existing property and provided the longest possible runways in all directions. A typical installation occupied one mile square with all support buildings concentrated in one corner. A standard "Figure 4" runway pattern occupied the remainder of the field. March Field was the first major field to implement the design during its major expansion in the late 1920s. An equilateral triangular configuration was another standard runway design that was implemented. This design assured runways within 30 degrees of the wind direction.[54]

In the early 1920s, the Air Service continued to focus on establishing air power outside the United States. In FY20, funds for overseas bases amounted to $350,000 for stations in the Philippines. In FY21, Congress appropriated $1.3 million for the establishment of aviation facilities in Hawaii and another $239,000 for aviation facilities in Panama.[55]

SUPPORT TO CIVIL AVIATION

The Air Service supported the parallel development of civil aviation in the United States, and civil engineers helped encourage that goal. Private and municipal airfields provided additional landing and servicing facilities for military aircraft when needed and also helped to support training and proficiency requirements for active duty pilots and reservists. In 1920, the *Aircraft Year Book* listed only 115 permanent airfields under U.S. control—including Army and Navy fields. These fields were located in 32 states, the District of Columbia, the Canal Zone, and Hawaii.[56]

In 1919, the Air Service established a prototype Model Airway, an experimental airline service that was the first in the nation to operate regularly-scheduled flights between fixed points. The Buildings and Grounds Office undertook extensive mapping and data collection to support the system and to ensure that all parts of the country eventually could be served under the system. Commuter service initially was established between Washington, D.C., and Dayton, Ohio, with an intermediate stop at Moundsville, West Virginia. When Warren G. Harding became President in 1921, he supported the development of transcontinental airways and encouraged such activity. He directed the Air Service to work with other government agencies to establish workable routes and to coordinate with individual states to construct municipal airports. This work had the dual benefit of stimulating commercial aeronautics and bolstering national defense by ensuring that Army aircraft could move quickly from one part of the country to another.[57]

When Maj. Gen. Mason Patrick became Chief of the Air Service in October 1921, he diverted funds from other activities to establish a permanent Airways Section in his office. In 1922, the Model Airway maintained regular service for both passengers and cargo between McCook, Bolling, Langley, Moundsville, Selfridge, and Mitchel fields. In 1923, a southern division was added from Scott Field to Kelly Field, by way of Kansas City and Dallas. By 1925, the Buildings and Grounds Office had compiled information on nearly 3,500 landing places in the United States.[58]

The Buildings and Grounds Office continued to conduct studies and to make plans for continental air routes until that function was transferred to the Department of Commerce under the Air Commerce

Act of 1926. In addition to the economic benefits of the Airways system, a tremendous body of information was gathered on existing and potential landing fields, weather, and topography in the United States.[59]

THE AIR CORPS ACT OF 1926

Developments in the Air Corps from 1920 to 1926 demonstrated the potential for air power to support national defense and helped the Air Corps slowly but steadily gain stature in the eyes of War Department and Congressional leaders. Several committees and boards studied the question of the status of the Air Service in the early 1920s. The Morrow Board appointed by President Calvin Coolidge studied the "best means of developing and applying aircraft in national defense." Its findings were translated into legislation known as the Air Corps Act, signed on July 2, 1926. The act served as a watershed for the development of military aviation in the United States.

The Air Corps Act changed the name of the Air Service to the Air Corps, "thereby strengthening the concept of military aviation as an offensive, striking arm rather than an auxiliary service." The act created an additional Assistant Secretary of War position to help foster military aeronautics and established an air section in each division of the General Staff for a three-year period. Significant internal reorganization accompanied the creation of the Air Corps. Three major divisions—Operations, Materiel, and Training—were each headed by a brigadier general. The Operations Division was the only one located in Washington, D.C. The Materiel Division eventually moved its headquarters to Wright Field in Dayton and the Training Division was established at the Air Corps Training Center at Kelly Field.[60]

The Buildings and Grounds Office in Washington became part of the Materiel Liaison Section in September 1926. In 1927, it was made an independent section under the Executive, Office of Chief of the Air Corps. Its mission significantly expanded over the next seven years and included supervising the design of Air Corps technical buildings and installations, and all real estate transactions. The office also acted as a liaison with the Construction Service of the Quartermaster Corps and carried out Air Corps policies pertaining to construction, repair, and salvage of structural improvements at Air Corps stations. It also was responsible for preparing estimates for all present and future construction, and for managing the allotment of funds to carry out projects.[61]

THE AIR CORPS EXPANSION PROGRAM

The Air Corps Act authorized a Five-Year Expansion Program to bring the Air Corps up to strength and to modernize its aircraft fleet. The expansion program called for a goal of 1,800 serviceable airplanes, 1,500 officers, and 15,000 enlisted men. As was normal with such legislation, the Air Corps Act did not specifically mention ground facilities. It was clear, however, that increased personnel and equipment would drive the growth and improvement of air stations that housed and trained personnel.[62]

The Chief of the Air Corps produced a comprehensive development plan for ground facilities. It proposed 32 fields for further development, two entirely new airfields, the development of a major Air Corps Training Center at Randolph Field, and the construction of an additional airfield in Panama. Planners estimated that $18 million in technical construction and 17,000 new housing units would be required to refurbish and modernize Air Corps stations. Technical requirements included 125 hangars, 20 field shops, 8 depot shops, 24 field warehouses, 68 operations and headquarters buildings, 16 photo buildings, 7 school buildings, petroleum-oil-lubricant storage units, and extensive improvements to landing fields.[63]

The five-year expansion program was managed by the Quartermaster Corps. The Quartermaster Corps employed a group of distinguished professionals, both uniformed and civilian, to apply the latest theories in urban planning to the development of Air Corps posts. The team of planners, including George B. Ford and 1st Lt. Howard Nurse, believed that a post design should be harmonious with the natural surroundings. The new permanent posts reflected the principles of the "garden city" and "city beautiful" movements in urban planning. Ford argued that aviation had an impact on post designs. The patterns formed by the buildings when viewed from the air were studied to present attractive post plans. The new plans maximized the use of open space near the public areas of the post, while integrating irregular street patterns where appropriate. The Quartermaster Corps incorporated regional architectural traditions into the standardized designs. Generally, the Georgian or Colonial Revival style prevailed in the northeastern states, while the Spanish Mission style was deemed most appropriate for the southern regions. Other architectural styles found at Air Corps installations included French Provincial and Tudor Revival.[64]

The Construction Division of the Quartermaster Corps worked with Air Corps personnel and installation commanders to plan construction for Air Corps installations. Examples of this collaboration are found in the designs of Randolph Field, Texas, and Barksdale Field, Louisiana. Capt. George Lamb, Constructing Quartermaster at Barksdale Field, recalled that the decision to design the buildings using the French Colonial style was made in consultation with the Chief of Air Corps.[65] The dramatic layout of Randolph Field is attributed to a young Air Corps officer, Harold Clark, who conceived the design and presented it for approval to Brigadier General Lahm.[66] As reported by Maj. E.G. Thomas,

> The Air Corps furnishes requirements as to the size of hangars, shops, warehouses, etc.; the amount of gasoline storage needed; the size of runways to provide landing and take-off facilities for its airplanes, to the Construction Division, Office of the Quartermaster General. The relations between the services and the Construction Division, O.Q.M.G., are much the same as when private industry furnishes the architect, the engineer, and the contractor, with its requirements to permit of adequate plans and specifications being prepared and facilities constructed.[67]

In 1928, the Air Corps received $1 million for improvements to stations. These funds allowed for construction of new barracks and non-commissioned officer (NCO) and officer quarters at Selfridge, Maxwell, Mitchel, and France fields. In 1929 and 1930, that program was extended to three more fields, and technical construction was accomplished at Fairfield, Langley, March, Middletown, and

Randolph AFB's iconic Taj Mahal.

Scott. Among other technical advancements, night lighting was installed at five bases in 1929 and another five bases in 1930.[68]

In San Antonio, the Air Corps secured title to the land that would become Randolph Field in August 1928, after the city offered 2,300 acres at no cost to the government, and construction began in October. The new headquarters of the Air Corps Training Center, touted as the "West Point of the Air," was dedicated in June 1930 and received its first cadre of training units from March and Brooks Fields in 1931. The Taj Mahal at Randolph, originally constructed as the base administration building, ingeniously enclosed a 50,000-gallon water tank and soon became the symbol of flying training.[69]

The Materiel Division's aeronautical development and testing complex at Wright Field benefited from the expansion program. Although the majority of the original technical buildings were completed prior to the dedication of Wright Field in October 1927, construction continued on buildings to accommodate the design and testing of whole airplanes, parts, and equipment. Facilities completed in 1929 included the Aircraft Radio Lab, a facility to house the large wind tunnel that moved from McCook Field, the post fire station, and the central heating plant. Earmarked appropriations of $300,000 in FY 1931 funded the construction of 18 buildings between 1930 and 1933 to house research, development, and testing functions.[70]

The Five-Year Plan called for establishing a large base to house a full wing in the southern U.S. The city of Shreveport, Louisiana, purchased more than 23,000 acres with local bond revenue and donated the land to the federal government in November 1930. The Air Corps named the site Barksdale Field and developed it to include a gunnery and bombing range. It ultimately became home to the 3d Attack Group.[71]

The construction at Barksdale, Randolph, and Wright Fields gave each airfield its own distinctive architectural style. This reflected the Army's intention in the late 1920s to infuse thoughtful and comprehensive design into its military complexes. The Quartermaster Corps went to great lengths to convey the seriousness of purpose that the technical aeronautical buildings deserved, combined with beauty and style, especially in the case of military housing. Wright Field with its neo-Classical brick, factory-style design with large windows and minimal ornamentation; Randolph and March Fields with their Spanish Mission style, arcades, balconies, and tile appointments; Patterson Field with its

Quarters #1, an example of Patterson Field's English Tudor officer's quarters.

English Tudor officers' quarters; and Barksdale with its French provincial architecture reminiscent of New Orleans, all made bold statements about the permanency and forward-looking determination of the Air Corps.[72]

As the Air Corps prepared to enter the third year of the expansion program in June 1929, Chief of the Air Corps James Fechet elevated the Building and Grounds Division to one of nine divisions at Air Corps Headquarters charged with handling the Five-Year Plan. In FY31, a Plans Division was created to keep the program on track; Brig. Gen. Benjamin Foulois served as chief. That division charted a detailed chronological program to govern the remainder of the expansion program. Charts showed that $12 million worth of construction was completed at Air Corps stations by the end of FY31, only a small proportion of the total program originally envisioned. Ultimately, two stations were added to the Five-Year Program—Rockwell and Middletown—and the end date for the program was extended to 1933.[73]

Until 1932, the bulk of appropriations was directed towards barracks and new housing. During the last two years of the program, flying field facilities and technical buildings received increased emphasis. Significantly, the word "runway" was mentioned for the first time in the annual report of the Chief of the Air Corps in 1932. The report also mentioned that hydraulic gasoline systems were being installed at selected airfields.[74]

Both housing and technical construction programs fell short of their goals and Congress cancelled or postponed a number of unfinished projects at the end of the program. Changing technology was responsible for delays; program requirements were a moving target. Larger aircraft required larger hangars, generally increasing hangar width from 110 to 120 feet. New fire prevention systems and other improvements added to the cost of design and construction.[75]

Despite some shortcomings, the Five-Year Plan resulted in significant gains in the number and quality of installations. The Air Corps oversaw the construction of more than $34 million worth of housing units for its personnel and $20 million in research, development, and test facilities that endured through the beginning of World War II.[76]

Table 1.1 Construction Budgets During Air Corps Expansion Program

Fiscal Year	Air Corps Construction Budget for Improvements to Air Stations	Quartermaster Corps Obligations for New Air Corps Construction
1927	$300,000	$1,376,000
1928	$1,062,471	$2,124,000
1929	$1,736,619	$8,086,221
1930	$3,598,376	$9,100,981
1931	$5,144,175	$8,685,349
1932	$5,938,990	$13,955,220

Source: Lt. Col. Thomas E. Greacen II, "The Buildings & Grounds Office of the Army Air Corps 1918 – 1944," Mar 29, 1944, 13-19.

THE HEART OF THE DEPRESSION

When the Air Corps expansion program officially ended in 1933, the Air Corps still found itself with many unfulfilled requirements for modernized construction. A significant amount of construction was performed under the auspices of relief agencies established during President Franklin Roosevelt's "New Deal." Beginning in 1933, funds appropriated to the Civil Works Administration, the Federal Emergency Relief Administration, the Public Works Administration, and later the Works Progress Administration helped accomplish projects that otherwise might have gone unfunded during sparse economic times, and relief workers provided much of the labor involved. Approximately $1.5 billion in relief funds was channeled to construction and maintenance of airways and airports, both civil and military, from 1933-1939, and monies from relief agencies continued to augment construction on Air Corps bases through 1941.[77]

The Materiel Division at Wright Field, in particular, worked in harmony with national relief programs to get projects done and employed a large number of personnel under various public and civil works programs. In FY 1935 over $500,000 in projects was performed at Wright Field by public contract under supervision of the Constructing Quartermaster. Those projects included construction of a new static test building for aircraft structures and the large Technical Data building that became the home of the Army Aeronautical Museum. In FY 1937, and again in FY1938, $76,000 in projects was allotted to Wright Field by the Works Progress Administration (WPA). A total of nearly $120,000 in WPA projects was performed in FY 1939 under supervision of the Chief of Maintenance, primarily repairs and improvements to buildings, grounds, and public utilities. In FY 1940, WPA funds allocated for work at Wright Field exceeded $221,000. The Civilian Conservation Corps also maintained camps on a number of Air Corps installations. The young men living in the camps had no official relationship with the military posts, but they did assist with grounds maintenance and other tasks.[78]

Another positive aspect of the Depression was that manufacturers, while business was at a very low ebb, were able to place within the reach of the construction industry many new materials, particularly non-corrodible alloys that retained their original luster, ceramic products in a wonderful range of colors, and acoustical materials that could be used for sound absorption as well as interior decoration. Those improvements showed up in many military buildings, especially those that featured Art Deco architecture.[79]

The first fireproof hangars were developed, involving gypsum fireproofing of steel structures, and were adopted for general use. A deluge-type automatic sprinkling system for protecting airplanes and equipment in hangars was developed from tests at the U.S. Bureau of Standards for the Chief of the Air Corps.[80]

By 1937, advancements in mechanical ventilating systems made it possible to maintain positive pressure for sterile environments, and the air supplied to medical facilities could be heated, cooled, cleansed by washing, humidified, or sterilized by ultra-violet rays. Air conditioning was beginning to make an appearance in buildings with specialized functions, such as equipment repair and calibration facilities.[81]

GENERAL HEADQUARTERS AIR FORCE EMPHASIS ON NATIONAL DEFENSE

The creation of General Headquarters Air Force on March 1, 1935 led to an increased emphasis on air bases as centers of air power for national defense. The General Headquarters Air Force concept partially fulfilled the idea of a "combat air force" separate from the Air Corps' aviation support function assigned to Army units. General Headquarters Air Force did not come under the operational jurisdiction of the Chief of the Air Corps but existed beside it, reporting directly to the Chief of Staff of the Army. Brig. Gen. Frank Andrews commanded the "independent air striking force" from his headquarters at Langley Field. The tactical units of the Air Corps were organized under three wings. These wings were headquartered at Langley, Barksdale, and March fields. In July 1936, to further delineate responsibilities, the Air Corps was given jurisdiction over its own permanent peacetime stations. Prior to this delineation, Army Corps Area commanders were in control of those installations.[82]

The location of Air Corps bases increasingly became integrated with general War Department plans for defense. A number of boards and committees conducted studies to define the exact requirements to assure an effective air defense. Those efforts included analyzing the number and types of aircraft for procurement, and methods to build air bases. Planning and discussion culminated in the introduction of several bills in Congress to establish air bases for the defense of the nation. The Wilcox Act of 1935 was the most important piece of legislation affecting flying installations. Its provisions gave the Air Corps the latitude to determine which sites should be developed within available appropriations. Almost all new installations and expansions of existing facilities after 1935 drew their authority from that Act.[83]

In December 1935, Gen. Oscar Westover became Chief of the Air Corps. Brig. Gen. Henry “Hap” Arnold served as his Assistant Chief beginning in January 1936. General Westover reorganized the office of the Chief along typical Army A-staff lines (A-1, A-2, etc.). The Buildings and Grounds Section came under the Supply Division of the A-4. In April 1936, General Arnold issued a memo to the Chief of the Supply Division suggesting that priority be given to the construction of technical buildings over housing. A special board of officers, including four brigadier generals, was convened to consider the ways and means of accomplishing essential construction. The board established priorities in line with Arnold’s direction. In order of importance, those priorities were: runways and airfields; technical and operational construction; administrative and general supply construction; and finally, housing and miscellaneous.[84]

The first major project to be approved was an air depot for the west coast in Sacramento, California. Construction began on the Pacific Air Depot after the constructing quartermaster reported for duty in June 1936. The repair facilities at the depot were the most modern and complete of their kind, featuring all the machinery required to repair and reconstruct aircraft for a large portion of the Air Corps. A 120-foot traveling crane operated the full length of the engineering shop, and trenches and pits in the concrete floor allowed for distribution of utilities from main junction points.[85]

In 1938, the depot was renamed Sacramento Air Depot and underwent a major expansion to repair and overhaul P-38 and P-39 fighters. Support facilities at Sacramento, such as the administration building, the hospital, quartermaster buildings, barracks and quarters were unique and featured architectural styles not found at other Air Corps installations. They featured reinforced concrete walls and flat roofs, with a modern design aesthetic. The need for economy combined with favorable climatic conditions influenced the choice of architectural style and construction materials.[86]

The second priority was the establishment of a base to defend the Pacific Northwest. In 1937, the city of Tacoma, Washington, donated its municipal airfield for the purpose. The War Department purchased the land between the airport and Fort Lewis, and construction began in 1938 on McChord Field.[87]

Hickam Field on the eastern shore of Pearl Harbor Channel was another complex base constructed in the 1930s. Active development of the field began in late 1935, after a seven-year delay in purchasing the necessary real estate. Hangars, operations buildings, and the field’s strikingly beautiful water tower were built in 1937. In April 1938, the constructing quartermaster received word that the size of the garrison was to be significantly expanded beyond original plans, necessitating revisions to the design to accommodate additional barracks. Appropriations for FY39 included funds for constructing more runways, repairing hangars, and installing additional gasoline and oil storage. The main barracks at Hickam was designed for a complete 3,000-man Air Corps wing, all housed and fed under a single roof. One-third of the officer and NCO quarters on base were multiple units in apartment-style buildings. By the end of 1940, the transformation of Hickam was complete and it became the home station of the 18th Wing and the Hawaiian Air Depot.[88]

Other important installations established in the late 1930s were the Air Corps Technical School at Lowry Field, Colorado; advanced gunnery and bombing ranges in the Mojave Desert near Muroc, California; and facilities on the Gulf Coast near Valparaiso, Florida. Maintenance and repair depots were built at Brookley Field, Alabama, to serve east coast bases and at Hill Field, Utah, to service western bases. Many operational fields received hard surface runways and modern navigational aids. The first Army runways to be paved were at Barksdale, Selfridge, and Mitchel Fields in the mid-1930s. The mission and image of the Air Corps reflected the development of the force and its serious commitment to defending the nation.[89]

THE LIFE OF A POST ENGINEER WITH THE AIR CORPS

Little has been written about the lives of the men who served as post engineers on Army Air Corps bases in the 1920s and 1930s. Serving on an Air Corps base was distinct from serving on a traditional Army base, which was home to an infantry, armored, or cavalry unit. Most engineers were graduates of the U.S. Military Academy at West Point, where they had little exposure to the world of Army aviation. Their experience likely was limited to visits to Stewart Field near Newburgh, New York, which was the closest Air Corps installation and the site for primary training for aviation cadets from the Academy. Once assigned to an Air Corps base, post engineers worked within a leadership structure that differed from traditional Army bases—with rated pilots as commanders, a culture of technology and new frontiers, and a mission keenly focused on the technical aspects of flying. This was a world that revolved around new technologies, making and breaking records, and constantly improving aircraft maintenance, aviation equipment, and airfields.

There is no evidence that future Air Corps post engineers received specialized training in airdrome maintenance at West Point, Command and General Staff School or the Army War College; the majority likely gained expertise through on-the-job experience. Construction and maintenance at Air Corps stations included responsibility for real estate and utilities, which was the responsibility of the Quartermaster Corps at the end of World War I. It is presumed that the post engineer either worked for, or very closely with, the post quartermaster. Maintaining the flying field, flight line hangars, and maintenance facilities would have been the highest priority followed by maintenance of administrative buildings, barracks for Airmen, family housing, roads, and grounds. Response to crash fires on the flight line, as well as to base fires, was also of critical importance. From existing records, it appears that firefighters were largely a civilian force and worked directly for the post commander. Guidance for fire marshals on military installations was provided by an Advisory Bureau of Fire Protection organized and maintained by the National Board of Fire Underwriters.[90]

An early fire station at Randolph Field, Texas, built at a cost of $14,904 in 1930.

BUILDING FOR WAR

The United States was stunned by the fall of Poland in September 1939 and the German conquest of Norway, Holland, Belgium, and France in spring 1940. In early 1940, a flood of appropriations reached the War Department. Congress and the White House quickly approved funds for a massive mobilization to defend the U.S. mainland and interests in the western hemisphere.

Despite the productive building program of the mid-1930s, the Air Corps lacked sufficient bases to support the military build-up anticipated. The combined number of Air Corps bases and civil airports in the United States were insufficient to accommodate the growing number of aircraft in production.

Existing airfields and housing also were unable to handle the growing wave of training programs for pilots, crews, and technical support personnel necessary to fill the ranks of a wartime Air Corps.[91]

The Air Corps witnessed dramatic changes between 1940 and 1942. Army Chief of Staff Gen. George C. Marshall signed the First Aviation Objective on June 26, 1940. It authorized the Air Corps to expand from 24 to 54 combat groups by April 1942, with 12,835 aircraft and 220,000 officers and men. In less than a year, President Roosevelt approved the Second Aviation Objective, which called for a force of 84 Air Corps combat groups and 400,000 troops by mid-1942. The impact on the expansion of ground facilities was profound.[92]

Few could foresee the total number of Air Corps installations that would be required to support training programs and operational requirements. During 1940 and 1941, the number of facilities in operation or under construction for the Air Corps doubled. Development of civilian airports also proceeded at an accelerated pace to help meet the demand. Congress allocated $139.5 million for the development of 399 civilian airports to meet military specifications. Personnel involved in the construction of civilian and military airports learned the criteria for building an efficient airfield: good siting, proper drainage, high-quality runway surfaces, airfield lighting, hangars, repair shops, fuel and oil service, facilities for pilots, meteorological service, communications equipment, customs service, concessions support, and good administration. All were accomplished with the greatest economy.[93]

The Air Corps program included installations both stateside and beyond U.S. borders. The new B-17 bomber, with its 3,000-mile range, expanded the operational area of the Air Corps. Since the mid-1930s, Air Corps planning had included the North and South Atlantic, Puerto Rico and the Caribbean, Alaska, Hawaii, and Panama. With war on the horizon, the Air Corps began looking at potential airfield locations in South America to support cross-Atlantic operations. In 1939, the Air Corps encouraged Pan American Airways to develop civil airports in various Latin American countries. In 1940, the War Department entered into a secret contract with Pan American Airways to build and to expand commercial airfields in Central and South America. All development funds came from the U.S. government and the U.S. Army Corps of Engineers oversaw the projects. Constructing the fields under the guise of private commercial development circumvented formal military agreements with host nations.[94]

Organizational changes in Washington accompanied the construction program. General Headquarters Air Force was separated from the Air Corps in November 1940 and given separate status under the commander of the Army Field Forces. On June 20, 1941, creation of the Army Air Forces brought air combat forces back under the command of air leaders and consolidated control of both

Lt. Col. Manuel Asensio

Lt. Col. Manuel Asensio played an important role in construction of wartime airfields in South America. Shortly after declaration of war in December 1941, he was assigned as a resident engineer in Brazil to oversee construction by Pan American Airways for the U.S. Army Corps of Engineers. During his six-month tour, he was responsible for monitoring construction at 17 airfields along the South Atlantic Air Transport route from the United States to Africa. He later served as the military attaché in Bogota, Columbia, and as commander of the Airborne Engineer Training Center at Westover Field, Massachusetts. He then deployed to the China-Burma-India Theater. He became the staff engineer for Tenth Air Force in Burma, where his engineers pioneered a method for cutting heavy equipment into several pieces for airlifting and then welded them back together after offloading. His last assignment during the war was as the Air Engineer for the Army Air Forces in China. He had a distinguished career with the postwar Air Force, and retired as a lieutenant general in 1960.

the Air Corps and the Air Force Combat Command. With the creation of the Army Air Forces, the War Department transferred direct responsibility for the selection of new stations to the Army Air Forces Commanding General. Previously, the War Department had appointed site boards that recommended final site approvals for Army aviation installations. General Arnold now gave the Buildings and Grounds Division the job of evaluating site recommendations for his approval. The Division came up with an elaborate scoring system based on several suitability factors, such as flying weather, terrain, location in relation to ranges, and availability of housing. After the adoption of the Second Aviation Objective, the Buildings and Grounds Division decentralized the selection process even further to expedite procurement of new bases. The division appointed a site board for each numbered air force and for each of the three Army Air Forces training centers.[95]

STATESIDE TRAINING BASES

Great urgency accompanied the construction of training bases in the continental United States. Between 1919 and 1939, the largest number of Air Corps pilot trainees to graduate in a year was 246. Under the First Aviation Objective, the goal for trained pilots rose to 12,000 a year after June 1940, followed by an almost immediate increase to 30,000 a year under the Second Aviation Objective. The demand for mechanics and technicians similarly escalated from 1,500 to 110,000 a year between 1939 and March 1941 to meet the goal for establishing 84 combat groups. All of those pilots and technicians underwent intensive training; by July 1940 the Air Corps only had eight advanced flying schools and three training centers. The Buildings and Grounds Division in Washington was responsible for drawing up facility requirements and estimating costs to build the airfields needed to accommodate the rapid expansion program.[96]

Fortunately, General Arnold foresaw the need for rapid training of a large number of pilots as early as 1938 and persuaded Congress to approve a plan establishing civilian schools as the primary provider of flight training for the Air Corps. Nine of the nation's best civilian schools operated primary flying training programs under contract to the Air Corps in the summer of 1939. By 1941, 41 schools were providing invaluable training. With civilian schools handling primary training, the Air Corps turned its attention to military basic and advanced flying training programs. These programs were held at the existing schools at Randolph, Kelly, and Brooks until mobilization began in earnest in summer 1940.[97]

Flying training fields sprang up almost overnight, mostly in the "Sunshine Belt" of the South and Southwest where favorable weather permitted year-round flying. Heading the list were multiple sites in Texas, Arizona, New Mexico, Nevada, and southern California. Eight airfields were placed in operation under the 54-group program, and 20 more authorized under the 84-group program were completed, or under construction, by the end of 1941. According to General Arnold, "It was not unusual to find a training field with dozens of planes flying above it, bulldozers on the ground finishing the earthwork, cement mixers turning out concrete for runways yet to be built, and men in the open still clearing brush from what had been grazing land."[98] Facilities construction comprised standardized wood-frame temporary mobilization buildings.

By early 1941, technical training facilities began to expand into the south. The sites of Keesler Army Airfield at Biloxi, Mississippi, and Sheppard Army Airfield at Wichita Falls, Texas, were recommended by a selection board. Land offered by those communities included local airports developed with relief funds between 1935 and 1939.[99]

Among the pilot training airfields in the south were Tuskegee Army Airfield and Moton Army Airfield in Alabama, where hundreds of African-American pilots were trained for service with the Air Corps. Under Public Law 18, the Civil Aeronautics Authority (CAA) established civilian schools for primary pilot training for African-Americans at the Tuskegee Institute and at three other locations in 1939. In 1941, the Air Corps was directed to organize a "Pursuit Squadron (Colored)," and the service began searching for a location to set up an advanced training program. The President of Tuskegee

Institute, Frederick D. Patterson, urged the Air Corps to consolidate the two programs at Tuskegee and to expand the facility. The Air Corps agreed and requested WPA funds to build Tuskegee Army Airfield as a separate, segregated facility near the Institute. Between 1941 and 1945, Tuskegee trained over 1,000 African-American aviators for the war effort.[100]

A second primary training field for African-American pilots was constructed near Tuskegee in 1941 to prepare cadets for the advanced training program at Tuskegee Army Airfield. Engineers from Maxwell Field provided assistance in selecting and mapping the site, and Tuskegee Institute laborers and skilled workers helped finish the field so that flight training could start on time. In addition to pilots, thousands of African-American support personnel were trained as flight instructors, bombardiers, navigators, radio technicians, mechanics, air traffic controllers, parachute riggers, and electrical and communications specialists; many were trained at Chanute Field.[101]

The Air Corps also was involved in training British pilots on U.S. soil under a provision of the Lend-Lease Act to ease pressure on over-taxed training facilities in the United Kingdom. The British government located land to establish six flying fields, subject to approval by the Air Corps and the Quartermaster General. The British then purchased the land, deeded it to the U.S. government, and leased the airfields. The fields were operated by civilian flying schools for one dollar a year. The U.S. Army Corps of Engineers supervised construction by private contractors, who were hired by the British government. Materials purchased from Lend-Lease funds were utilized. The first contingent of British flying cadets arrived in June 1941, and in July, Britain requested additional training facilities. By November 1941, about 3,600 British pilots were undergoing training at schools in Georgia, Florida, South Carolina, Alabama, and California.[102]

Although impressive, the pre-war construction from 1939 to 1941 was dwarfed by the airfield construction program that followed the U.S. entry into World War II in December 1941. Tremendous effort and extensive resources were expended on training facilities and operational bases, especially in the first six months of 1942. All of the construction was managed by the U.S. Army Corps of Engineers, which officially assumed responsibility from the Quartermaster Corps for Air Corps wartime construction in November 1940.

The Buildings and Grounds Division, which became an independent division within the Office of Chief of the Air Corps in August 1940, worked closely with the U.S. Army Corps of Engineers to monitor the massive construction effort. On June 30, 1941, the division had a staff of 50 officers and 75 civilians divided into six sections: Administrative, Planning and Maintenance, Airports, Real Estate, Construction, and Foreign Projects. In December 1941, the Division moved from the Munitions Building to the Maritime Building and, in June 1942, moved again to Army Air Forces Annex No. 1 at Gravelly Point near National Airport in Arlington, Virginia. Following the creation of the Army Air Forces, the division became a section under the Supply and Services Division, which was under the Assistant Chief of Air Staff for Materiel, Maintenance, and Distribution. Adding to its multiple responsibilities in 1943, the section also was assigned procurement and distribution of all night lighting equipment for the Air Corps, the Navy, and the CAA. On October 9, 1943, Col. James B. Newman, Jr., the chief of the Buildings and Grounds Section, was promoted to brigadier general and became the first general officer to head up the organization that would later become Air Force Civil Engineering. He served in this position for only a few weeks before being transferred to Europe. Effective June 12, 1944, the Building and Grounds Section was reorganized as the Air Installations Division headed by Brig. Gen. Robert Kauch, who arrived in September to become chief of the division.[103]

One of the section's highest hurdles was providing facilities for training programs. A partial solution was found in commercial hotels. Resort hotels in Miami Beach, St. Petersburg, Daytona Beach, and Atlantic City were leased and converted for training programs while the famous Stevens Hotel in Chicago was purchased by the government for a radio school. This strategy eliminated construction of four new schools and saved an estimated $40 million. The facilities were available immediately, thus avoiding construction delays and allowing vast amounts of critical war materials and labor to be diverted to other urgent projects. At the peak of the war, the Air Corps had lease arrangements with

Transfer of Wartime Construction from the Quartermaster Corps to the U.S. Army Corps of Engineers

Following the dramatic German victories of early 1940, the U.S. Congress passed appropriations acts totaling more than $9 billion in a five-month period. Of this money, $780 million was earmarked for the construction of Army installations and airfields. The Construction Division of the Quartermaster Corps rose to the challenge. The Quartermaster Corps had a heavy burden of responsibilities aside from construction. Many argued that the construction program should be aligned under an independent Construction Division or be transferred to the U.S. Army Corps of Engineers, which was better manned and equipped to manage the massive program.

In the political maneuvering over roles and missions that ensued, Army Chief of Staff Gen. George Marshall ultimately agreed that the pre-war construction load was more than the Quartermaster Corps could handle. He suggested that the program be transferred to the U.S. Army Corps of Engineers, although not all at once. On November 19, 1940, the U.S. Army Corps of Engineers inherited the construction program for all Air Corps stations in the United States. The Quartermaster Corps transferred 83 Air Corps construction projects to the U.S. Army Corps of Engineers between November 1940 and April 1941. Despite initial predictions of mass disruption, the transfer went relatively smoothly and actually led to better cooperation on the job by both agencies.

In the year between the initial transfer and the official U.S. entry into World War II, the U.S. Army Corps of Engineers oversaw Air Corps construction work, including 42 new airfields in the continental United States, complete with housing and technical facilities, and expansion of facilities at another 25 existing Air Corps stations. In mid-1943, General "Hap" Arnold commended the U.S. Army Corps of Engineers for completing 1,100 domestic military and civil airfield projects for the Air Corps and Army Air Forces over the past two and a half years, commenting that the work had been "prosecuted with outstanding efficiency and dispatch."

In December 1941, Congress officially completed the transfer of responsibility by turning over all domestic military construction to the U.S. Army Corps of Engineers. The President quietly signed the legislation on December 1, 1941. The law went into effect on December 16, just in time for the U.S. Army Corps of Engineers to launch the greatest military construction effort in U.S. history.

Source: Barry W. Fowle, ed., *Builders and Fighters: U.S. Army Engineers in World War II*, U.S. Army Corps of Engineers Office of History, Fort Belvoir, Virginia, 1992, 20-25, 95.

464 hotels. Another program for which the section took responsibility was the Flight Strip Program; emergency landing strips were built adjacent to existing highways across the country and along the Alcan Highway in Canada.[104]

From 1939 to 1945, facilities for the Air Corps/Army Air Forces expanded to include 783 bases and auxiliary airfields, 12 main depots, 68 specialized depots, and 480 bombing and gunnery ranges within the continental United States (CONUS). Counting other support facilities, the Army Air Forces had 2,252 domestic installations. They covered a land mass equal in area to the states of New Hampshire, Vermont, Massachusetts, and Connecticut. Army Air Force projects between June 1940 and August 1945 totaled $3.152 billion, or 29.5 percent of the total War Department construction expenditures.[105]. The network of air installations in the continental United States was valued at $100 million in 1940 and grew to a complex worth 30 times that amount by 1945. The dollars allotted to the Army Air Forces expansion accounted for almost 30 percent of appropriations spent by the War Department on domestic military construction during the period.[106]

Civilian members of the Army Air Forces Buildings and Grounds Section, October 1943.

Officers of the Army Air Forces Buildings and Grounds Section, October 1943.

Pressure to build new installations in the United States eased in late 1943 as the requirements for training bases were met and the need for continental defense diminished. Most new construction beyond that date was related to the very heavy bombardment training program. The Army Air Forces began identifying and closing excess installations, beginning with contracted functions and leased properties, in 1944. By the end of 1944, Army Air Forces reduced hotel leases from a peak of 464 to 75 and placed most surplus airfields in caretaker status. Some installations were used for POW camps, foreign laborers' housing, grazing leases, and other purposes. Army Air Forces transferred 84 stations to the Navy, which needed airfields near the coasts for carrier pilot training. From a peak of 2,252 installations as of December 31, 1943, the number declined to 1,811 by September 2, 1945. By the end of 1945, the Army Air Forces retained only 429 installations in the United States, including auxiliary fields.[107]

AVIATION ENGINEERS IN WORLD WAR II

While civil engineers made critical contributions to the war effort through construction on the home front, it was only part of the story. The other vital role that engineers played, of course, was in construction undertaken by combat engineer units in support of Army Air Forces flying operations in all theaters of the war. General Arnold knew first-hand the importance for Airmen to have engineers who trained with them, spoke their language, and understood their needs. He pushed for the creation of aviation engineer regiments within the U.S. Army Corps of Engineers to provide dedicated construction support to the Air Forces. In all, 157 Engineer Aviation Battalions saw duty during the war, 48 of which were segregated units composed of African-American troops. In addition, 16 Airborne Engineer Aviation Battalions were trained to parachute in, near, or behind enemy lines with specialized small-scale equipment. They also trained in preparing landing fields for forward operations. Their equipment was transported by C-47s or a combination of C-47s and CG-4A Waco gliders. Nearly 120,000 Aviation Engineers saw action in all theaters during the war. Together they built or improved 1,000 airfields around the world.[108]

Aviation engineer units were versatile. They were specifically trained to rapidly construct advanced airfields close to, or behind, enemy lines, but they also had the skills to maintain and improve existing facilities. Aside from Fort Belvoir, much of their training took place at Westover Field in Massachusetts and Eglin Field in the Florida Panhandle. They were masters in the art of camouflaging airfields and constructing defensive works such as revetments to disperse and protect aircraft. They specialized in rapid runway repair, quickly returning to service airfields that were damaged by enemy bombing. Finally, to protect themselves from air and ground attack, aviation engineers were trained and equipped for combat as well as construction. Each unit included trained riflemen and machine gunners who could take active part in the defense of airdromes. Units were armed with a variety of weapons including bazookas, antitank and antiaircraft guns, grenade launchers, armed half-tracks, antitank mines, and a full complement of small arms.[109]

The first such unit was the 21st Engineer Aviation Regiment, activated at Fort Benning, Georgia, in June 1940 under the command of Lt. Col. Donald A. Davison of the U.S. Army Corps of Engineers. The initial contingent comprised a handful of officers and 80 enlisted men, who moved to Langley Field the same month to undergo specific training. Members of the regiment constructed their own barracks and grounds, conducted experimental work on runways, and learned techniques for camouflaging airdromes. The experimental runway at Langley was constructed in sections with different techniques to expose trainees to a range of technologies—soil-cement, soil-asphalt, two types of steel landing mat, and soil stabilization with Vinsol resin.[110]

The 21st became the parent unit for a wave of aviation engineer units. Each aviation engineer regiment consisted of a regimental headquarters, a service company with headquarters, and three battalions. Each battalion included a headquarters company and three lettered companies (A, B, and C Companies). Total strength of a regiment was 79 officers and warrant officers and 2,207 enlisted men. Regular engineer aviation battalions were self-contained, 800-man units. Airborne engineer aviation battalions had 28 officers and 500 men. A few separate engineer aviation companies, not attached to battalions, were organized to meet specific needs when limited personnel were available.[111]

Each engineer aviation battalion was authorized 220 pieces of heavy construction equipment—diesel tractors with bulldozers, carryall scrapers, graders, gasoline shovels, rollers, paving equipment, air compressors—and 146 vehicles, plus standard hand tools. Sets of specialized equipment, such as additional asphalting and concreting equipment, rock crushers, draglines, pumps, and floodlights, were available when needed. With three companies and supplemental labor and equipment, a battalion could work on up to three airfields simultaneously. Each unit also had its own contingent of equipment maintenance personnel, which was essential under combat conditions.[112]

Before the attacks on Pearl Harbor, engineers from the 21st participated in the U.S. Army General Headquarters Maneuvers, which were held to prepare troops for combat. They joined Company C of the 810th Engineer Aviation Battalion from MacDill Field to take part in the Louisiana Maneuvers.[113] Maj. Gen. Lesley James McNair, who served as Chief of Staff for the Army's General Headquarters, along with his staff organized the Louisiana Maneuvers to provide the most realistic scenarios possible. General McNair supported unstructured maneuvers, where commanders were free to make their

> ***"Whereas a little over a year ago the term 'aviation engineer' had no real official significance, we now recognize that it would be no wiser to send a long range bomber out minus a navigator than to attempt to operate an air force without the specially trained aviator components of the U.S. Army Corps of Engineers that had been assigned by the War Department to work intimately with us."***
>
> Maj. Gen. Henry H. "Hap" Arnold, "The Air Forces and Military Engineers," The Military Engineer, Vol 33, No 194, December 1941, 545.

own decisions and judgments about tactics. In addition, General McNair abolished practices such as simulating the destruction of a bridge while using it for transportation. He required troops to find a way around bridges designated as destroyed, which added realism and forced troops to consider other options and strategies. He also eliminated rest periods that broke the mindset of troops from actual maneuvers, claiming that it "lessens realism and training value."[114] The Louisiana Maneuvers took place between September 15 and 28, 1941 and covered 30,000 square miles of land in Louisiana. Approximately 330,000 men participated in the maneuvers, which were considered one of the largest Army versus Army challenge in history.[115]

The 21st Engineer Aviation Regiment was notified of its participation in the realistic training opportunity. They traveled from Langley Field in Virginia to Louisiana and Texas. The engineers arrived two weeks prior to the actual maneuvers and aligned with Company C of the 810th Engineer Aviation Battalion. Their primary mission was to renovate and to provide support for landing fields for the maneuver. They completed work on runways and taxiways and improved roads and parking. They also fulfilled concealment duties, camouflaging aircraft shelters and airfields to evade "enemy" assaults by ground or air. Their hard work was recognized. Lt. Gen. Delos C. Emmons, then Commanding General for the Air Force Combat Command, commented on their accomplishments, "these exercises certainly justified the requirements for Aviation Engineers and the need for many additional ones becomes more and more apparent."[116]

One example of their construction efforts was the expansion of runways at Monroe Airport in Louisiana. In order to complete the job, aviation engineers transported 1,500 cubic yards of gravel from 10 miles away. The gravel was placed, packed down, graded and topped with asphalt. The runway was increased by 500 feet within two weeks. Other work included the removal of vegetation and other hazards located around runways. Work at the airfield in Natchitoches, Louisiana required hauling 2,000 cubic yards of fill-gravel from a location 21 miles away. In Beaumont, Texas, the airport runways were extended by 1,000 feet using 10,000 cubic yards of shell provided by the municipality. Concealment efforts at the Natchitoches airfield included the creation of fake hedgerows, creating the appearance of a divided pasture. At Camp Beauregard, the 21st Engineers Aviation Regiment simulated farm houses using webs of wire to mask the airfield. Another camouflage technique involved painting circles on the runway to create the appearance of an orchard from the air. The engineers also created "dummy planes" out of wood and burlap to serve as decoys for bombers flying overhead. These deception techniques were ideal because the imitations were not detectable as decoys by cameras at 15,000 feet or through visual observation from 10,000 feet. Reconnaissance flights were rarely flown below an altitude of 10,000 feet because of the risk of attack by the opposition.[117]

At the conclusion of the Louisiana Maneuvers, the 21st Engineer Aviation Regiment made its way to the Carolinas to join the First Army (IV Corps) Maneuvers, where it constructed the first field airdrome in the United States with a pierced steel plank runway. The runway was 3,000 feet long and was created for use by the 1st Air Support Command. It was designated the "Marston Strip" and was located in Hoffman, North Carolina. The runway took 11 days to complete and required 18 train cars of pierced steel planks. The steel planks were developed by the Carnegie Illinois Steel Company to address the need for transportable material for use in runway construction. When General Arnold reviewed the

Soils School

The Army Soils Control School at Harvard University was an important contributor to winning the air war. Sponsored by the U.S. Army Corps of Engineers, the school was the brainchild of Professor Arthur Casagrande. As a consultant on airfield design during spring 1942, Casagrande realized the Army needed men trained in soils engineering. He established a six-week course for officers; the first class of 24 newly-commissioned lieutenants reported to Harvard on July 3, 1942. They received a rapid but intensive survey of soil mechanics and related subjects, including laboratory sessions, field trips, and lectures by top experts in the field. The course was given repeatedly until mid-1944 and graduated 400 students. The Aviation Engineers made good use of their knowledge at airfield projects around the world. As one general officer commented in late 1943, "What we have learned in our civil works program about soil strengths . . . has contributed to feats of military engineering that have astonished the world."

Source: Lenore Fine and Jesse A. Remington, *United States Army in World War II, The Technical Services, The Corps of Engineers: Construction in the United States,* Center of Military History, U.S. Army, Washington, D.C. 1989, 642-643.

completed runway at Hoffman, he declared it "the year's greatest achievement in aviation."[118] The 21st continued its efforts in the Carolina maneuvers, camouflaging the Laurens and Spartanburg airports in South Carolina and grading runway extensions at several other airfields. Afterward, the 21st Engineers reported that the maneuvers lived up to the 21st regimental motto: "Expect Anything." [119]

The 803d and 804th Engineer Aviation Battalions were created from the 21st Engineer Aviation Regiment cadres and were shipped immediately to the Hawaiian Islands in March and April 1941. They did not have the advantage of taking part in exercise maneuvers or receiving initial training at a technical training center. They became the first aviation engineers to see combat during the attacks on Pearl Harbor and Hickam Field in December 1941.[120]

Recognizing the increasing numbers of aviation engineer units, the Headquarters, U.S. Army Air Forces in Washington, D.C., formally established an engineer component in 1940. The position of Air Engineer was established by May 1941. The role of the Air Engineer was to advocate for specialized training and equipment for aviation engineer units in airfield construction and to monitor the overall functioning of the units for the Air Staff. Brig. Gen. Stuart C. Godfrey held the position of Air Engineer from May 1941 until December 1943, when he was sent to India to supervise the construction of B-29 bases. His successor, Col. George Mayo, then served as the Air Engineer until the end of the war. During an Air Staff reorganization effective March 29, 1943, the Air Engineer became a separate office within the AC/AS Materiel, Maintenance and Distribution office, which was one of six offices reporting to the Chief of the Army Air Forces. The staff office in Washington was modest in size and had no direct command authority over the aviation engineer units stationed in theaters of war. The Air Engineer maintained liaison with the U.S. Army Corps of Engineers and the AAF Materiel Command concerning training and equipment issues for the aviation engineers. He also published an excellent journal, *Aviation Engineer Notes*, which served as a source of technical guidance for engineers dispersed worldwide and gave them a sense of identity and *esprit de corps*.[121]

Command authority over aviation engineer units was vested in the respective theater-of-war commanders where the units were stationed. In Washington, D.C., the Operations Division of the War Department General Staff, rather than the Air Engineer, was responsible for distributing battalions on the basis of strategic need and availability of shipping. As the war progressed, command and control of in-theater aviation engineer units varied. The most common command structure in which aviation engineers served was through the Supply of Services, where aviation engineers were grouped with Navy and Army engineers and assigned to projects as needed, or through a theater engineer command.[122]

In the period between the beginning of World War II in Europe on September 1, 1939 and the

Brig. Gen. Donald A. Davison

The commanding officer of the first-ever aviation engineer unit was Col. Donald Angus Davison. As the head Engineer for General Headquarters Air Force, he played a major role in organizing aviation engineer battalions to support the Army Air Forces in World War II.

A 1915 graduate of the U.S. Military Academy, Colonel Davison had a broad background not only as an engineer but also as an educator. He served with the 11th Engineer Regiment in Panama and later as the District Engineer at the Louisville District of the U.S. Army Corps of Engineers. He also spent two years as a professor of Military Science and Tactics at Yale University and another two years as Senior Instructor at the Engineer School at Fort Belvoir. As a major and lieutenant colonel, he served as an instructor at the Army Command and Staff College at Fort Leavenworth from 1932-1936. One of his fellow instructors was Lt. Col. Lewis Brereton, who later became commander of the Ninth Air Force during World War II and a strong supporter of Colonel Davison and his wartime engineers.

In June 1940, Colonel Davison was appointed commander of the 21st Engineer (Aviation) Regiment, which was activated at Fort Benning, Georgia, in October 1939. In 1941, while serving as the General Headquarters Air Force Engineer, he developed the plan to permit the Army Air Forces, through the aviation engineers, to build their own bases in forward areas. After the United States entered World War II, he served as the chief engineer under Gen. Dwight D. Eisenhower for the Allied Force Headquarters in England. He also served under Gen. Carl A. Spaatz for the Northwest African Air Forces in the critical early months of the North African campaign. He established and took charge of the XII Air Force Engineer Command (later renamed Army Air Forces Engineer Command, Mediterranean Theater of Operations) in late 1943. He was the first aviation engineer to lead a dedicated Engineer Command. He also served as the Fifteenth Air Force Engineer.

In March 1944, he was ordered to Washington, D.C. to serve as the Air Engineer at Headquarters Army Air Forces. He was on detached service in Bangalore, India, when he fell ill and died on May 6. His untimely death came as a blow to his colleagues and deprived the engineering community of one of its brightest leaders. He was buried at Arlington National Cemetery and was posthumously promoted to Major General. Davison Army Airfield at Fort Belvoir, Virginia, is named in his honor.

attacks on Pearl Harbor on December 7, 1941, the Air Corps oversaw a series of dramatic construction efforts throughout the western hemisphere. By 1941 the Army Air Corps was in a decidedly better position to train combat air forces and to engage in actual combat than the nascent air arm of the Army 24 years earlier.

Alaska

The Air Corps recognized the strategic importance of the Territory of Alaska and began conducting aerial photography and surveys for mapping during the late 1920s. The concern that Alaska might one day come under attack was not new; plans for at least one military airfield in the unprotected territory surfaced as early as 1935.

The Air Corps was interested in the route to Alaska and in bases for the defense of Alaska itself, including the expansive Aleutian chain that stretched toward Japan. In 1936, General Arnold ordered a survey of possible sites for airway stations from Seattle to Juneau; at the time, there were only five landing fields more than 2,000 feet long in the entire territory. The resulting report recommended five sites that, if developed, would permit military aircraft to reach Alaska avoiding Canadian air space.

In late 1936, the War Department appointed a board of officers to select a site in the vicinity of Fairbanks for an aviation base. As a result of funding restraints, it took three years for the plans to move forward. The Air Corps wanted to establish two bases in Alaska, one for operations and one for cold weather research. The original intention to host both missions at one base proved unrealistic. Anchorage, which was strategically located along the southern Alaska coast, was selected as the site for a main tactical base; it could be supplied much easier and had a more equable climate. Fairbanks, which had the climatic conditions ideal for experimental flying, was selected as the home of the Army's major cold weather experimental station.

The first construction personnel arrived at Fairbanks in fall 1939 to begin building Ladd Field. To the surprise of all, according to General Arnold, they accomplished what was previously considered impossible. Concrete work and carpentry proceeded throughout the winter. By early summer 1940, construction was well underway. Troops began arriving to man the Air Corps' first aerial arctic outpost in September 1940. They conducted tests to determine better methods of equipping aircraft for arctic operations.[123]

In June 1940, construction began on Elmendorf Field at Anchorage. The field was adjacent to the principal Army headquarters at Fort Richardson. Plans for Elmendorf were coordinated with the construction of Navy air and submarine bases in the Aleutians, at Sitka, Kodiak, and at Dutch Harbor in Unalaska, which the Army would also use. A temporary hangar was ready by early 1941, and flying units began to arrive from the United States. By fall, the field was capable of supporting tactical operations.[124]

Troop labor helped construct needed bases along the route to Alaska. The War Department collaborated with the CAA, which had a program to build and improve airfields in the territory, to construct two bases in the Alaska Panhandle. The first was at the southern tip of Annette Island and the second was near the village of Yakutat at the northern end. With fields in those two locations, aircraft could make the 1,500-mile trip from Seattle to Ladd Field in relative safety. Apprehensive that the CAA would take too long to build the fields, the U.S. Army Corps of Engineers recommended that combat engineers build the field at Annette. It assigned the job to the 28th Engineer Aviation Regiment.

Two battalions of the 28th Engineer Aviation Regiment accompanied by two companies of the Civilian Conservation Corps from Oregon and California and 35 civilian technicians began work at Annette in late August 1940. The regiment also sent a detachment to perform work at Yakutat. The

(above) Construction on Elmendorf's runway.
(right) Construction at Elmendorf Field, 1941.

U.S. Army Corps of Engineers, Seattle District, supervised the construction of two 5,000-foot asphalt runways, concrete aprons and taxiways, a hangar, a dock, a seaplane ramp, roads, housing, and storage facilities at Annette. Work continued into 1941, when the 802d Engineer Aviation Battalion was occupied fully developing the airfield at Annette. Their work included lengthening the runways to 7,500 feet. Meanwhile, the 807th Engineer Aviation Company was making improvements at Yakutat.[125]

The Air Corps also relied on the CAA to provide additional airfields in Alaska for emergency landings and observation points. In 1939, the CAA began to build airports and airway facilities in Alaska that conformed to military standards. In 1941, the CAA completed Class III defense airports with 4,000 to 6,000-foot runways at Juneau, Northway, Big Delta, and Nome; work at seven other sites also was underway. Construction at all of the Alaskan bases posed incredibly difficult challenges for engineers.[126]

Panama

The Air Corps considered the Canal Zone the most critical to defend of all the outlying U.S. territories. In January 1939, when Secretary of War Harry Woodring and Army Chief of Staff Gen. Malin Craig outlined their defense program before the House Committee on Military Affairs, they requested $23 million to improve air power in Panama.[127]

France Field on the Atlantic side of the Canal Zone and Albrook Field on the Pacific side were air bases of long standing. Howard Field, originally part of Fort Kobbe at the Pacific end of the Canal Zone, was expanded dramatically starting in 1940. Rushed to completion by the Constructing Quartermaster, 10,000 acres of impenetrable vegetation at Howard were transformed into a “thriving, highly-industrialized city of 5,000 inhabitants.” The work was completed in less than a year and it became an independent installation in June 1941. All structures were permanent buildings of concrete and steel designed to withstand the rigors of the harsh climate. The concrete runway was constructed by the Severin Company, which provided its own equipment and labor. The Constructing Quartermaster oversaw the grading and supplied the needed materials. More than 85,000 square yards of concrete were placed by Panamanian laborers in 21 days. The new concrete was first covered with water-soaked burlap, followed by a coat of black asphalt emulsion to avoid cracking caused by high temperatures and rapid evaporation during curing.[128]

The only U.S. defense installation outside the Canal Zone was Rio Hato Airfield, 50 miles southwest of the Pacific entrance to the canal. The field, which originally was a private landing strip for a nearby resort, was leased by the Air Corps for 200 dollars a month. By 1939, it had become so important for defense that Air Corps commanders in the Canal Zone urged the War Department to buy the field or to lease it on a long-term basis. In August 1939, the U.S. Army Corps of Engineers acquired $2.5 million to improve the road from the Canal Zone to Rio Hato, and, in late 1939, the 11th Engineers began to improve the airfield. Construction accelerated in the summer of 1940 when materials and heavy equipment arrived by sea. That year the rainy season lasted from May to December and Col. Earl North, the Canal Zone’s department engineer, complained that “the clayey earth became a soft sticky gumbo.” The 11th Engineers also built a 2,000-man camp for the 9th Bombardment Group, which arrived in November 1940.[129]

In 1941, Gen. Frank Andrews, commander of the Caribbean Air Force, pressed for the completion of nine auxiliary airfields in Panama. Technically, the Quartermaster Corps was still responsible for the construction. The Constructing Quartermaster was over-extended and the U.S. Army Corps of Engineers insisted that engineers be allowed to complete the work. Beginning in March, two companies of the 11th Engineers were assigned to the fields and were assisted by the 805th Engineer Aviation Company. Their goal was to accomplish as much work as possible before the start of the rainy season. By June, six emergency landing strips were graded and ready to receive aircraft.[130]

Atlantic and Caribbean Bases

In the North Atlantic, the United States was vulnerable to the action in Europe via Iceland, Greenland, and Newfoundland, none of which had adequate air defenses. In the South Atlantic, Natal on the exposed angle of Brazil, was only 1,600 nautical miles from the coast of Africa. The islands of the Caribbean were poorly fortified, leaving the eastern approaches to the hemisphere vulnerable to considerable German submarine traffic patrolling the waters.

Solidarity of the nations in the Western Hemisphere was reaffirmed in the Declaration of Lima in December 1938. The declaration led to a series of inter-American agreements. Unlike the Pacific, plans for defense in the Atlantic depended on such agreements to secure privileges from individual nations or from friendly European powers that still had possessions in the region. The impetus to band together for common defense became stronger after Germany invaded western Europe in early 1940. It appeared that England might also fall under the Nazi advance, denying the Allies friendly bases within striking distance of Germany. In August 1940, the governments of the United States and Canada established a permanent joint board to coordinate defense measures for North America. The board decided that Air Corps units should be stationed at Newfoundland Airport at Gander Lake as soon as possible, where U.S. troops assisted with maintenance. Eventually the U.S. Army Corps of Engineers supplemented Gander by building Harmon Field at Stephenville on Newfoundland's west coast.

Construction in Iceland also received an early priority. England occupied the island in May 1940, following an air attack by Germany in February. The United States agreed to supplement and eventually to replace the British garrison there. Army aviation engineers ultimately worked on four airfields in the country. Two companies of the 21st Engineer Aviation Regiment, later designated the 824th Engineer Aviation Battalion, arrived in Reykjavik on July 7, 1941 as part of the first Army contingent on the island. They augmented the construction program begun by the British at Reykjavik Field and at Kaldadharnes Airdrome 35 miles southeast of the capital. Although the airfields were usable, they needed considerable work to conform to U.S. standards; they had to be expanded to accommodate heavier air traffic. The first priority was to complete troop housing, covered storage, and hospital facilities and to extend the docks in Reykjavik harbor. Once heavier construction equipment arrived, they laid the foundation for a British prefabricated hangar, paved hangar aprons, and supervised construction of perimeter roads surrounding the base. Iceland had no railroads, and the lack of roadways made long-distance hauling of bulk supplies impossible. Other than rock, sand, and gravel, all engineer supplies had to be shipped from the United States and Britain.[131]

In November 1941, U.S. engineers began working at the Kaldadharnes site. Survey parties began laying out what was to become the largest airfield in Iceland at Keflavik, 25 miles southwest of the capital. The Keflavik airdrome was just a grass field with a runway 1,000 yards long and 50 yards wide, suitable for emergency use only. Two separate fields, Meeks Field for bombers and Patterson Field for fighter aircraft, eventually were built and were ready for operation in early 1943.[132]

In mid-1941, the Air Corps Ferrying Command began ferrying American-built planes to friendly nations overseas as part of the Lend-Lease program. Until the bases in Iceland were fully operational, the northern route to Europe ran from Bolling AFB to Montreal, to Gander Lake, and then to Prestwick Airport at Ayr, Scotland. In 1941, the United States entered into an agreement with Denmark, granting the United States the right to construct, maintain, and operate landing fields and other facilities in Greenland, in exchange for limited defense responsibilities on the island. A company of the 21st Engineers installed a temporary 3,500-foot pierced-steel plank runway at Bluie West 1 in Greenland in fall 1941. The southern route to Europe initially ran from Miami to Trinidad, through Belem or Natal in Brazil, and on to Bathurst, Gambia. Additional bases in British and Dutch Guiana became available through yet another initiative.[133]

In September 1940, President Roosevelt announced that he had reached an agreement with Great Britain to transfer 50 aging U.S. destroyers in exchange for the right to establish air and naval bases

Table 1.2 World War II Bases in the Atlantic and Caribbean

Country	Airfield(s)
Antigua (Britain)	Coolidge Field
Aruba (Netherlands)	Dakota Field
Ascension Island (Britain)	Wideawake Field
Bermuda (Britain)	Kindley Field
British Guiana (Britain)	Atkinson Field
Cuba	Batista Field
Curaçao (Netherlands)	Hato Field
French Guiana (France)	Rochambeau Field
Jamaica (Britain)	Vernam Field
Puerto Rico	Borinquen Field; Losey Field
St. Lucia (Britain)	Beane Field
Surinam (Netherlands)	Zandery Field
Trinidad (Britain)	Waller Field; Edinburgh Field; Xeres Field

at eight strategic British possessions in the Atlantic and the Caribbean. A 99-year lease gave the United States access to Newfoundland, Bermuda, the Bahamas, Jamaica, Antigua, St. Lucia, Trinidad, and British Guiana. By the end of October, a board of Army, Navy, and Marine Corps officers had visited each location and selected sites for potential military installations. General Marshall assigned construction at those locations to the U.S. Army Corps of Engineers. The Chief of Engineers formed a Caribbean Division to direct the work and set up four new construction districts in Newfoundland, Bermuda, Jamaica, and Trinidad. After the U.S. entry into the war, several more bases were added in the Caribbean on Curaçao, Aruba, Surinam, and Cuba.[134]

The greatest progress in air defense in the Caribbean between 1939 and 1941 took place in Puerto Rico, where the emergency strip at Borinquen Field was quickly transformed into a major air base (renamed Ramey in 1948). Construction also began on Losey Field. By spring 1941, sufficient aircraft and personnel were on the island to activate a composite wing. By the time Pearl Harbor was bombed, Gen. Frank Andrews commanded 300 Army aircraft in the Caribbean area, but all heavy bombers and most of the best fighters were stationed at bases in Panama.[135]

Hawaii and the Pacific

The United States had maintained air stations in Hawaii and the Philippines since the early years of military aviation. By 1940, Wheeler and Hickam were the two major Army airfields located on Oahu in the Territory of Hawaii. Army air units stationed there—the 18th Bombardment Wing at Hickam and the 14th Pursuit Wing at Wheeler—existed primarily for defense of Pearl Harbor and other naval and military installations on the island. Oahu also had an observation squadron at Bellows Field, 28 miles from Hickam, and a pursuit squadron in training at Haleiwa in the northern part of the island.[136]

Planners knew that significant development and expansion of facilities would be required, both to provide defense for the territory and to allow Hawaii to provide transit services for aircraft being ferried to the Philippines and points in the Pacific. The Honolulu District of the U.S. Army Corps of Engineers drew up plans to expand runways to at least 5,000 feet. Eight runways were to be enlarged and modernized and two new ones were added. The Hawaiian Department commander lacked resources and progress was slow. Engineers made up only three percent of his garrison, versus the more typical eight to ten percent. The Department especially needed aviation engineers. The 804th Engineer Aviation Company arrived in April 1941, followed by the 34th Engineer Combat Regiment in June. The 804th was soon raised to battalion strength. By mid-summer work was underway on five military airfields:

three on Oahu, one on the island of Hawaii, and one on Kauai. With the help of the CAA, emergency and auxiliary fields also were established on each island in the Hawaiian group.[137]

In fall 1941, the United States began deploying B-17 bombers to reinforce the Philippines. The existing ferrying route that traversed Midway, Wake, and Guam risked exposure to Japanese forces in the Mandated Islands (former German possessions in the Marianas, Carolines, and Marshalls). The Army Air Forces received approval to develop a more secure route via the South Pacific and Australia. The War Department allotted an initial $5 million, and in mid-October 1941 construction was ordered for Christmas Island, Canton Island, Fiji, and New Caledonia. Construction was also planned for Australia at Townsville and Darwin, and at Fort Stotsenburg in the Philippines. The project received the highest priority rating of A-1-a to meet an anticipated completion date of January 1942.[138]

Each location initially had one 5,000-foot runway suitable for heavy bombers and all were eventually expanded to include three runways at least 7,000 feet long, with gasoline storage facilities and buildings for servicing crews. Australia, New Zealand, and the Free French collaborated to complete much of the initial construction, but the 804th Engineer Aviation Battalion aided by civilians completed most of the work on Christmas Island. The largest obstacle for all of the projects was delivery of supplies and equipment to the remote Pacific outposts, particularly given the priorities system in the military procurement chain.[139]

In the Philippines, there were only two Army airfields in 1940, Nichols Field south of Manila and Clark Field about 50 miles northwest of the capital. Nichols had a paved runway but, like the turf strips at Clark, was too small to handle B-17s safely. By October 1940, $4 million was allotted to develop a network of modern airfields—four on Luzon, two on Mindanao, and a score of smaller fields to disperse B-17s throughout the islands. The scope of the project was overwhelming for the small engineer department in the Philippines, which struggled to get construction underway before the start of the rainy season in June. With no construction troops available, the department retained local construction firms. Work began in April 1941 on four projects on Bataan Field. In June, work began on Kindley Field on Corregidor, and within the next three months ground was broken on new airfields at Del Monte and Malabang on Mindanao and O'Donnell on Luzon. Crews battled mud and torrential rains throughout the monsoon season and were hampered by the 7,000-mile supply line from the United States.[140]

The arrival of aviation engineers in July boosted the airfield construction program. The 809th Engineer Aviation Company reported to Nichols Field with a complement of modern equipment. The engineers worked around the clock operating their own machinery and managed 800 unskilled local laborers working on the project. At Clark Field, the 803d Engineer Aviation Battalion arrived in October 1941 and began extending the turf runways. Company A of the 803d took over the project at O'Donnell Field, and Company B of the 803d worked on Del Carmen Field on the Bataan peninsula. Effective December 1, the 809th became Company C of the 803d. By late 1941, five airfields in the Philippines stood ready to handle B-17s, three on Luzon and two on Mindanao. They would see action much sooner than they anticipated.[141]

England

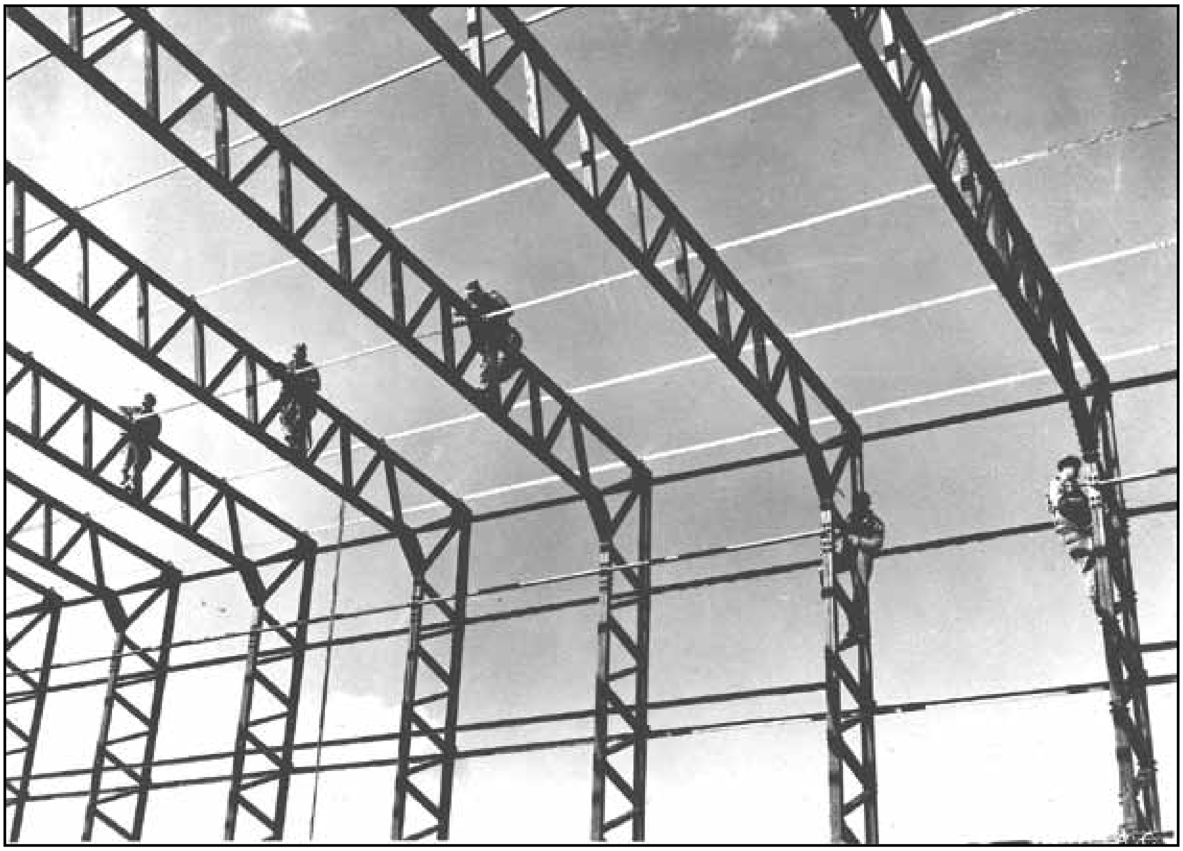
The first aviation engineers arrived in England in late spring 1942. Their mission was to help general service regiments build bases for the scores of U.S. aircraft that were soon arriving. They then turned their attention to how to support air operations for the invasion of the continent. The number of bases required to bed down the U.S. force became a moving target, especially after planners decided to base two numbered air forces in England (Eighth and Ninth); one was strategic and one was tactical. In four short months, the number of aviation engineers in the country grew from 2,150 in July 1942 to over 40,000 in November, but nearly 19,000 of them were soon drawn off to support the war in North Africa when that theater opened.[142]

The engineers faced two principal challenges. The first was that they lacked sufficient training to do the job. The number of recruits assigned to the U.S. Army Corps of Engineers doubled in the first six months of the war and they deployed almost immediately. Many units were brought up to strength only at the port of embarkation. Aviation engineers were lucky to receive even basic training, much less specialized training. For example, the 830th Engineer Aviation Battalion received 82 percent of its enlisted men and 50 percent of its officers in just ten days between July 29 to August 9, 1942; they were en route to Fort Dix for embarkation on August 11. The hope persisted that basic training could be completed in England and that troops could learn their special skills on the job. Aviation engineers gained general construction experience; however, they were so busy building permanent bomber bases they had no time to learn how to build rudimentary emergency airfields in forward areas, much less specialized skills, such as removing mines and booby traps.[143]

The engineers' second challenge was lack of equipment. Generally, their Class II equipment (tractors, power shovels, road graders, etc.) did not reach them until weeks after they arrived in England because it came by slower freighters. The 817th Engineer Aviation Battalion, which arrived in July 1942, reported that it had one transit, 100 axes, and 100 shovels for 800 men. They began clearing land with hand tools. Two months after arriving in late summer, four battalions had received less than one-third of their heavy equipment, which they had yet to learn how to operate. They borrowed British equipment when it was available, but such loans were limited. It wasn't until the end of 1942 that Army engineer units in England had 90 percent of their heavy construction equipment and 70 percent of their vehicles. Fortunately, the quality of equipment provided to the engineers was generally acceptable. With their heavy graders, bulldozers, paving machines and other equipment, U.S. engineers usually outperformed British engineers, who primarily used lighter equipment.[144]

Mud became a real problem when autumn rains began in mid-October 1942, turning fields into bogs and company areas into quagmires. During the summer, units worked double shifts to take advantage of the long northern days. With the shorter days of fall, they worked under lights. Two, and sometimes three, shifts kept heavy equipment running day and night. Lack of timber also posed

Members of the 831st Engineer Aviation Battalion at work in England.



Strung out like notes on a musical score, members of the 834th Engineer Aviation Battalion construct a hangar in England.

problems for construction. In the United Kingdom virtually no construction was wooden and every piece of timber was under the control of the British Timber Control Board. One aviation engineer unit traded food for enough lumber to build concrete pouring forms. Many structures at British airdromes were of brick construction, which required training a large number of engineers as masons and conscripting men who were experienced in the trade as teachers.[145]

The Army Services of Supply controlled all construction matters in England. Despite repeated efforts, the Eighth Air Force was unable to gain control of the aviation engineers who were supporting its needs. The most telling aspect of that arrangement was the lack of training that engineers received in preparation for the upcoming invasion of Europe. The Services of Supply kept them so fully employed that they were only allotted one hour a day for combat training. They also were assigned to perform non-construction duties such as loading and unloading ships. Fortunately, that situation was rectified by the creation of IX Engineer Command prior to the Normandy invasion.[146]

North Africa

Three task forces spearheaded the campaign to break the Axis hold on North Africa in November 1942. The aviation engineer units supporting those task forces were the first to see combat and prove their skills under combat conditions. The Western Task Force sailed directly from the United States to Casablanca in Morocco. Its goal was to take the port and adjacent airfield at Casablanca then establish communications with the Center Task Force, which had the primary mission of capturing the port of Oran in Algeria. An Eastern Task Force, largely British, had responsibility for seizing Algiers and its two airfields at Blida and Maison Blanche.

The 21st Engineer Aviation Regiment accompanied the Western Task Force and landed directly from the United States, as did two airborne aviation engineer units, the 871st Airborne Engineer Aviation Battalion and the 888th Airborne Engineer Aviation Company. The latter two units were hastily formed and trained at Westover Field just weeks before joining the convoy to Europe. Despite the lack of experience of any of the engineers, and their complete unfamiliarity with the conditions of forward airfield construction in a fluid campaign, they helped capture Port-Lyautey Airfield on November 10. After Navy destroyers silenced enemy artillery, the engineers began repairs on the airfield.[147]

Four engineer aviation battalions from England—the 809th, 814th, 815th, and 817th—accompanied the Center Task Force assault forces at Oran. Problems with equipment transportation quickly became evident. The 809th's equipment was on a ship that developed engine trouble and was forced to return to England. When the 809th finally received its trucks, they had been stripped of spare tires and tools. The 814th had its heavy equipment appropriated by another unit after it came ashore. The ship carrying the 815th's equipment was torpedoed by the Germans and sank. The 2d Battalion of the 21st Engineer Aviation Regiment found itself using secondhand French tools and improvised equipment. Brig. Gen. Stuart C. Godfrey, Air Engineer, visited North Africa in January 1943 and reported, "The outstanding factor as to the aviation engineer units is their shortage of heavy equipment…. It cannot be too strongly emphasized that engineer troops without equipment are about as useful as pilots without planes."[148]

Initially, U.S. units busied themselves resurfacing damaged runways near the larger cities and supporting air operations along the coast west of Algiers. Few runways were capable of handling the heavy invasion air traffic and they had to be maintained at all costs. Engineers also constructed six airfields in Spanish Morocco, to counter any German intentions of attacking the Allied bridgehead through the Spanish dependency.[149]

The aviation engineer units faced the obstacle of mud when they began work in earnest to build additional fields for the influx of aircraft. The engineers had landed during the rainy season. Brig. Gen. Donald A. Davison, chief engineer of the Allied Force Headquarters, described efforts to expand the airdrome at Tafaraoui in Algeria. "To any aviation engineer in North Africa, the word Tafaraoui does not mean an airport alone, it means also a malignant quality of mud; something like wet concrete and of bottomless depth. We still speak of any bad type of mud as Tafaraoui."[150]

Meanwhile, to give maneuvering room to the aircraft mired at Tafaraoui, Twelfth Air Force flew its B-26 medium bombers to Maison Blanche, where the 809th Engineer Aviation Battalion began work on a second runway. The engineers faced the same insidious mud, but were able to lay gravel-clay taxiways and hardstands in a large dispersal area. In December 1942, Maj. Gen. (later General) James Harold "Jimmy" Doolittle, the Twelfth Air Force Commander, called for additional fields in eastern Algeria to bring Allied air power closer to the front lines. Acting on French advice that dry weather prevailed at Telergma, General Davison flew to that airfield, located on a 3,500-foot-high plateau in the mountains of eastern Algeria. There he found a platoon of the 809th Engineer Aviation Battalion already working, having come by forced march from Maison Blanche. The 809th, assisted by Algerian and French troops, prepared an earth runway to handle B-26s in just ten days and went on to develop a complex of medium bomber fields in the Telergma area.[151]

The aviation engineers that were specially trained for airborne operations got their first taste of action at Biskra, a resort town farther south in Algeria on the fringes of the Sahara desert. General Doolittle wanted an all-weather airfield to base B-17s and B-24s closer to the action in Tunisia. French train control was so badly disrupted, he called on the 887th Airborne Engineer Aviation Company to bring its air-transportable equipment from Morocco, a thousand miles away. A convoy of 56 transport planes carried the engineers and their specially-designed miniature equipment to Biskra on December 13, 1942. Twenty-four hours later, the first B-17 arrived from Oran. Within four days the company completed two new fields of compacted earth to give the heavies a dry home within easy striking distance of the enemy. The main runway was so wide that three B-17s could take off abreast to launch attacks on targets in Tunis and Bizerte in northern Tunisia.[152]

The airfield at Bone, Algeria, the easternmost port available to the Allies, was perhaps the most difficult, but probably the most rewarding, to build. The only possible site for the all-weather airfield was a delta in the Seybouse River mouth, but the area was pure mud. Sand was available along the coast, but the sand dunes were on the opposite side of the river from the construction site. The engineers constructed a causeway across the river, a roadway on the delta, and began to haul sand for construction. A rare dry spell allowed them to transport the sand and finish the runway just hours before a rainstorm washed away the causeway. Shortly thereafter, they received the most gratifying of rewards. A B-26 returning from a mission became lost and was running out of fuel. While headed to ditch his plane in the Mediterranean Sea, the pilot happened to glance down and see "the longest runway he had seen in North Africa." He made one sharp turn and landed at Bone without enough gas left to taxi the plane off the runway.[153]

Through active planning and cooperation between engineers and planners, the aviation engineers were almost always on the front lines; sometimes they were even ahead of them. One night General Davison was looking for the engineers of B Company, 814th Engineer Aviation Battalion. He was stopped by sentries, who wanted to know if he was aware that he was going out in front of their patrols. He said no but asked if a certain engineer company had come through and if they were out in front. The sentries replied, "Yes, if you mean those damn fools who wouldn't pay any attention to us and took those big machines out, we think they are about 10 or 15 miles down the road." He found B Company dug in with its defensive weapons already at work.[154]

The aviation engineers proved themselves in North Africa. During the campaign, ten aviation engineer battalions and two separate companies built or improved 129 airdromes. Gen. Carl Spaatz, commander of the Northwest African Air Forces, reported to General Arnold that the aviation engineers had proven themselves "as nearly indispensable to the Army Air Forces as is possible to ascribe to any single branch thereof."[155]

Central to their success was the close working relationship forged between engineers and fliers in North Africa. One lesson learned from the early days of the North African campaign was that aviation engineer units were best aligned under the operational control of a single agency subordinate only to the air forces. Otherwise, the engineers often received conflicting orders and experienced frustrating delays between the time when airfield requirements were identified and when construction could actually begin. General Davison convinced General Spaatz of the efficacy of streamlining the chain of command. He was given permission to establish a separate aviation engineer command, which became known as XII Air Force Engineer Command, Mediterranean Theater of Operations (Provisional). On January 1, 1944, the name changed to Army Air Forces Engineer Command, MTO (Provisional). That decision played an important part in the later creation of Ninth Engineer Command prior to the Normandy Invasion. General Davison was appointed commanding general on November 4, 1943. He appointed area engineers for Northwest Africa, Sicily, West Italy, East Italy, South Italy, Sardinia, and Corsica.[156]

Sicily, Italy, and Southern France

At Casablanca in January 1943, Great Britain and the United States agreed that Sicily would be the next objective in the Mediterranean. A major objective was to capture airfields so Allied air forces could reach profitable targets in northern Italy, Germany, Austria, and the Balkans. The chief airfields in Sicily were clustered on the northwest portion of the island near Palermo and on the opposite end of the island on the southeast coast. Combat engineers were given the job of preparing landing strips as soon as possible after the assault, having the runways at Comiso and Ponte Olivo Airfields ready by D+8. They were also responsible for building bulk fuel storage and pipelines to supply aircraft that would use the airfields.[157]

Bucking Bulldozer

The Aviation Engineer's "Bucking Bulldozer" first appeared in the summer of 1943 and represented the essence of engineering support to the Army Air Forces during World War II. A rather ferocious-looking bulldozer, with eyes, teeth, and wings, holds a piece of pierced steel planking, the material used to construct hundreds of runways, taxiways, and parking aprons around the world. The engineer riding the bulldozer wears a shovel on his back and is ready to fire his weapon. This was clearly a prototype for the RED HORSE emblem adopted in the 1960s.

Aviation engineers prepare to go to battle with "General Mud" at an airfield near Anzio, Italy.

Information on Operation Husky was slow in flowing to the engineers. Unit commanders were briefed only after embarking for Sicily on July 10, too late for realistic pre-invasion training. They belatedly learned that the main assault had been redirected to the southeastern beaches of the island instead of Palermo. Nevertheless, the aviation engineers from the 809th, 814th, and 815th Battalions were able to keep up with the whirlwind campaign, repairing captured airfields at Comiso, Biscari, Ponte Olivo, Gela, and several other fields. At Gela they also built dummy airfields to attract German bombers. On the northern coast, the 815th cleared a captured airdrome near Palermo and scratched out bases for fighters and transports east of the city. Once the Germans withdrew, engineers prepared 13 fields dispersed over Sicily to support projected troop-carrier operations. Permanent airfields were completed at Comiso, Ponte Olivo, Borizzo, and Palermo.[158]

The next goal in the Mediterranean was to eliminate Italy from the war. The first invasion forces came ashore south of Salerno as part of Operation Avalanche on September 3, 1943. A detachment of the 817th Engineer Aviation Battalion constructed three temporary landing strips for fighters, repaired Montecorvino Airfield and moved air force supplies from beaches to airfields, to support fly-in squadrons of fighters.[159]

The tough Italian land campaign lasted throughout the winter. U.S. aviation engineers laid emergency airstrips for fighters again in Calabria and for the campaign at Anzio. They assisted British engineers in building two all-weather bases in the Naples area. At Cercola, near the base of Mt. Vesuvius, engineers experimented with fresh volcanic ash from the brooding volcano as a substitute material for paving runways. When Mt. Vesuvius later erupted, immobilizing 82 B-25s, engineers cleared a road so that the stricken aircraft could be taxied away. From late October until January 1944, they enlarged and strengthened six airfields and constructed eight others for heavy bombers in

Aviation engineers used every available source of materials. Here they construct aircraft revetments using wooden wine barrels filled with dirt and sandbags near Anzio.

the Apulia region, near Foggia and Cerignola. In both locales the heavy winter rains of "sunny" Italy caused serious but not insurmountable difficulties.[160]

The Allied offensive into northern Italy over the summer of 1944 was supported by the 815th, 817th, and 835th Engineer Aviation Battalions. They built a dry-weather field on the former Anzio beachhead, rehabilitated a captured air base after removing several hundred Teller mines left by the Germans, and followed ground forces into Rome. They also readied three airfields for transports and medical evacuation aircraft. The 815th then continued northward, repairing cratered runways and doing whatever was required to make captured airdromes usable by Allied forces.[161]

The burden on aviation engineers became even heavier when the decision was made to develop airfields on Sardinia and Corsica. Again, rain and mud were their constant enemies. In Corsica, they faced extreme difficulties transporting supplies and equipment because the Germans—as they had in Italy—had destroyed every bridge and most roads. Engineers found themselves with insufficient equipment and personnel to accomplish their work, which ranged from repairs and drainage to building steel-plank or paved runways up to 6,000 feet in length. They augmented their limited personnel by employing small numbers of French aviation engineers on Corsica and appropriating large numbers of Italian prisoners of war in Italy and Sardinia. Despite all their difficulties, during November and December they completed, or were in the process of completing, more than 45 airfields. Construction of a medium bomber base at Decimomannu included widening the runway to more than 1,000 feet to permit six B-26s to take off simultaneously.[162]

All of southern Germany, including two of the largest German aircraft factories that produced almost 60 percent of its aircraft, was within comfortable range of the bases in southern Italy; Ploesti in Romania also was easier to attack. North of Naples, the aviation engineers built three new fields, adding to eight already available. As the Allied front moved north, Pisa, Florence, and Pontedera were captured and their airfields were repaired and enlarged. Aviation engineers prepared 45 tactical airfields and 25 bases for heavy bombers in Italy. Air operations from Italian bases split the German defenses. This became particularly important after the Normandy Invasion when the Eighth Air Force began striking deeper into the heart of the Reich.[163]

NORMANDY TO V-E DAY

As the campaigns waged in North Africa and Italy, the Royal Air Force and the U.S. Eighth Air Force prosecuted the Combined Bomber Offensive against Germany—the British flyers by night and the U.S. flyers by day. At the same time, the planning staff at Ninth Air Force was finalizing calculations for Operation Overlord, the campaign to liberate Europe starting with the invasion at Normandy.

Advanced airfields clearly would be a determining factor in the success or failure of the mission and aviation engineers would have to construct them as rapidly as possible. They had to consider such factors as procedures for stockpiling materials in England and getting them delivered to France. French harbors silted up during the German occupation so port conditions had to be determined. Ship-to-shore pipelines would be needed to deliver fuel for vehicles, and the condition of local roadways, bridges, and inland waterways also were a concern.

Initially, no separate engineer command was planned. In light of experience in North Africa where aviation engineers functioned as an integral part of the air force, the Ninth Air Force commander, Lt. Gen. Lewis Brereton, strongly pressed for an engineer command. He directed the engineer section of the Ninth Air Force headquarters to assume the functions of a command. The Ninth Air Force Engineer established a provisional command. Engineer aviation battalions and regiments in theater under the control of the Services of Supply since 1942, were transferred to the command beginning December 1, 1943.[164]

Early organization, planning, and training for the Normandy Invasion was carried out under the direction of Col. Karl B. Schilling until the IX Engineer Command was officially activated on March

30, 1944. The new organization, commanded by Brig. Gen. James B. Newman, Jr., had four regiments, each with four battalions of engineers. In addition, IX Engineer Command headquarters retained control of three airborne battalions and a camouflage battalion. They also oversaw miscellaneous smaller units, for a total of 20,000 men. Most battalions were veteran organizations with more than a year of heavy bomber airfield construction experience in the United Kingdom.[165]

The aviation engineers were assigned hefty goals in support of the invasion. The first was to go ashore with the invasion force on D-Day, together with their equipment. Their mission was to establish two emergency landing strips by the end of the first day, one on Utah Beach and one on Omaha Beach. Members of Company A of the 819th Engineer Aviation Battalion were selected to land at Utah Beach. Elements of the 820th and 834th Engineer Aviation Battalions were assigned to land on Omaha Beach. Once the emergency landing strips were in place, battalions would concentrate on building refueling and rearming strips on Omaha Beach by D+3 and multiple advanced landing grounds on both Omaha and Utah Beaches by D+14. A total of 35 advanced landing grounds were called for in the first 40 days of combat to accommodate the operation of 58 squadrons of aircraft. A briefing officer at the assembly area in England set the tone for the operation when he told members of the 834th Engineer Aviation Battalion, "you engineers have the vital job of paving the way for the air cover to back us up all the way to Berlin. Each base you build will be a stepping stone toward victory because the faster you move and work, the faster 'the air' moves and gets at the enemy—up close where it counts." The engineers set out with purpose and determination, but soon were enmeshed in the reality of combat.[166]

At 1050 hours on June 6, 1944, Lt. Herbert H. Moore led the first squad from Company A of the 819th onto Utah Beach. They waded the final 200 yards from their landing craft to the beach in waist-deep water with their waterproofed D-7 tractor close behind. Two more squads landed shortly afterward, bringing with them two motor graders, a 2½ ton truck, and another tractor. Men and equipment dispersed on the beach with only one casualty from shrapnel and waited for the infantry to capture the site of the emergency landing strip they were to build. As it turned out, they had dispersed their equipment on mud flats, but they were able to extricate it and moved to the construction site by 1800 hours. In a little over three hours, by 2115, they completed their mission and finished the landing strip. The weary engineers dug foxholes and spent their first night in France avoiding constant sniper fire.[167]

The landings at Omaha Beach did not go as smoothly. Elements of the 834th made repeated attempts to land but it was not until D+1 that they were able to beach at the nearest feasible location, several miles east of the planned site. The remaining elements of the unit landed up and down the coast. The scattered troops met at their in-transit area but found the planned sites for airfields still under enemy control. The lead party of the 820th likewise did not make it ashore until the second day of the invasion. On D+2, the two units found another suitable location near St. Laurent-sur-Mer. They rapidly scraped out an emergency landing strip while waiting for the other sites to be captured. In the meantime, the Army made an urgent request for an airstrip to evacuate wounded soldiers and to receive emergency supplies, so the engineers developed the emergency landing strip into a transport strip. By 2100 hours on D+2 they had constructed a 3,500-foot by 140-foot runway that received its first aircraft the following morning. Although unplanned, St. Laurent-sur-Mer became the first operational U.S. airfield in France. For the next several weeks, an average of 100 C-47s landed at the airfield daily. With nearly 15,000 wounded evacuated from the airfield, it was considered the principal transport field in Normandy until mid-July.[168]

Engineers began constructing more extensive fields as soon as possible, and aircraft began flying sorties under the roulement process. They departed from a base in England, completed a first mission, and then flew one or more missions from a continental field before returning home. Fortunately, planes could operate from continental bases when the airfields of southern England experienced bad weather. Eventually, the engineers themselves received badly-needed cargo. They received critical spare parts by June 20 and a shipment of 5,000 rolls of Hessian mat for runway surfacing on June 27. By the end of June, 11 U.S. fields were in operation, with five more under construction. By August 5, the aviation engineers had built or improved 17 fields in the liberated area.[169]

Brig. Gen. James B. Newman, Jr.

Brig. Gen. James Newman brought a wealth of experience to the position of Commander, IX Engineer Command. A native of Talladega, Alabama, he graduated from the U.S. Military Academy during World War I in 1918. By the time the United States entered World War II, he had worked in five different district engineer offices, had been a professor at two different universities, and led the design and construction of Washington National Airport. His first assignment with the Air Corps came in 1941, when he served briefly as the District Engineer at Wright Field. In October 1941 he was transferred to the Office of the Assistant Chief of Air Staff, where he was appointed chief of the Buildings and Grounds Division. In November 1943, he joined Eighth Air Force in England and, in March 1944, was appointed to head the newly-created IX Engineer Command. Under his leadership, the engineers assigned to IX Engineer Command assured the success of the Normandy Invasion and the conquest of Europe by building, repairing, and maintaining nearly 250 airfields and performing essential engineer services for all U.S. and French air units. He retired in 1946, only to be recalled to active duty two years later for service with the new U.S. Air Force. He served as the Director of Installations from May 1949 to May 1950 in the rank of major general. The Society of American Military Engineers' Newman Medal is named in his honor.

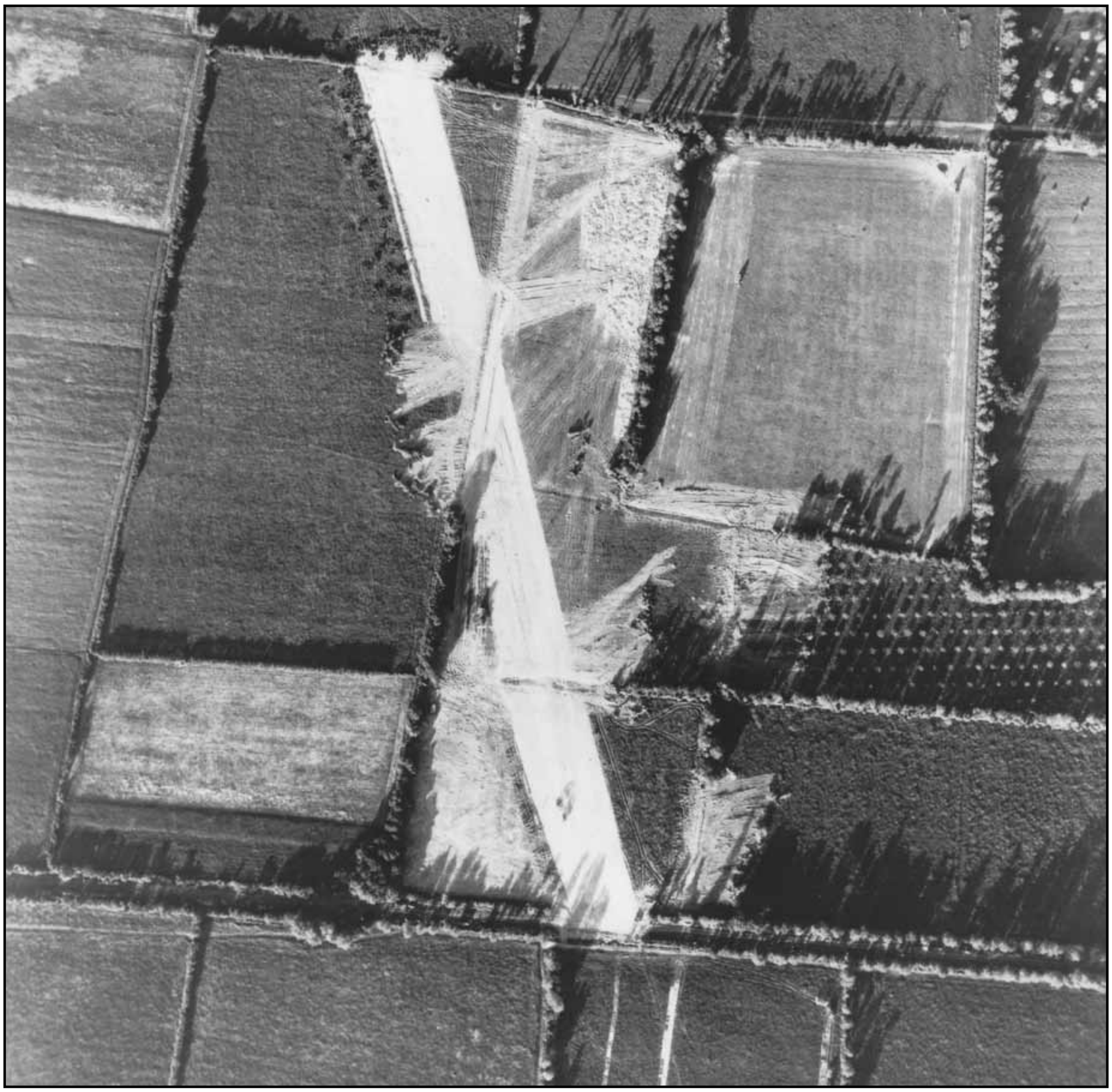
Source: Department of Defense Office of Public Information Press Branch, "Major General James Bryan Newman, Jr.," June 5, 1950, 1-3, Files of AFCEC History Office, Tyndall AFB, Florida.

Original plans called for approximately two-thirds of the runways to be built to fighter specifications, 3,600 feet long. Given the Luftwaffe's ineffectual reaction to the invasion, the Ninth Air Force decided to base fighter-bombers in France. The bombers required 5,000-foot runways of stronger construction to take off with full bomb loads. Fighter-bombers began operating from Normandy on June 19, just 13 days after the invasion. The success of the air campaign was attributable, in large part, to the fact that the aviation engineers were able to build and rehabilitate airfields in proximity to the front lines. They moved in right behind the ground forces under conditions that were uncertain and often dangerous. Engineers reported that they frequently came under enemy small arms fire or artillery attack and, occasionally, air attack. In one location, they left a hedgerow standing at the end of the field to screen their bulldozers from enemy snipers. Fortunately, casualties were few.[170]

As the First and Third Armies moved across France, it became harder to exercise control over the engineer units and keep them adequately supplied. To improve matters, IX Engineer Command was split into the 1st and 2d Engineer Aviation Brigades, with its four regiments divided evenly. Operation Dragoon, the invasion of southern France in August 1944, gave aviation engineers an opportunity to demonstrate the expertise they gained in rapid airfield construction during the Italian campaign. A pre-invasion bombing program began on August 10, with aircraft primarily launching from 14 airfields on Corsica that had been prepared by the aviation engineers. The actual invasion touched off with an airborne assault on August 15. Six battalions of aviation engineers went to work clearing everything from mines to grapevines in order to construct four new airfields and to convert 21 existing bases for Allied use. By the end of the first week of the operation, fighters and fighter-bombers were operating from bases in southern France.[171]

In August, airfields around Paris were reconnoitered while the Germans were still withdrawing. Engineers were ahead of the infantry and working under sniper fire, which resulted in the unfortunate deaths of two key IX Engineer Command officers as they investigated Le Bourget Field north of Paris. Col. Augustine Patterson Little, Jr., was a regimental commander for the IX Engineer Command. On August 27, 1944, Colonel Little, Col. James W. Park, Lt. Col. Gil Hall, and their driver, Corporal Gordon Farr, were completing reconnaissance efforts in an open vehicle at the airfield when they came under machine-gun fire from a wooded area. Corporal Farr was hit. In a rescue effort, the others attempted to move Corporal Farr from the vehicle

Hessian Matting:
Prefabricated Hessian Surfacing, known as Hessian Matting, was a Hessian cloth (a type of burlap) coated with bitumen. It had no load bearing capacity, but served as a waterproof cover for runways.



An emergency landing strip built on the Normandy coast by members of the IX Engineer Command.

to refuge in a ditch and to administer first aid. Both Colonel Little and Colonel Hall were fired upon. Colonel Hall died instantly; Colonel Little was hospitalized and died days later. The French government created a memorial plaque to honor Colonel Little and Colonel Hall; it was hung in the main terminal of the airfield. During the 1970s, the plaque was damaged and subsequently lost when the building was rehabilitated. These men were not forgotten; in 2002 the Le Bourget Lions Club initiated efforts to have the plaque replaced and rededicated.[172]

During the fall and winter, engineers focused on enlarging and winterizing airfields with large quantities of pierced steel planking (PSP), the only surfacing, other than concrete, that would stand up through the winter. Maintaining quickly-built airfields was a serious issue, as fields steadily deteriorated under constant use. In August 1944, IX Engineer Command organized, out of its own resources, the 1st Airfield Maintenance Regiment (Provisional) and attached it to the IX Air Force Service Command to maintain airfields in the rear areas. Some 10,000 French and Belgian civilians assisted in the maintenance work to help ease the burden. In Holland, local laborers helped the engineers build runways the Dutch way—out of brick. It took approximately nine million bricks to lay one runway, which was done expertly by the Dutch under the supervision of Airfield Construction units. By the end of August, six airfields were ready in the Orleans-Paris areas, and aircraft from England began delivering food to the residents of a liberated Paris.[173]

By the end of October, more than 90 percent of Ninth Air Force's total strength was deployed on continental bases thanks to the efforts of the aviation engineers. Even the Germans were impressed by the early work of the engineers in France and Belgium, commenting that the rapid, large-scale construction of airfields was a notable achievement of the Allied air forces. The engineers worked a grueling schedule—seven days a week, 16-17 hours a day. In spite of the backbreaking work, morale was high because the results of their efforts were evident immediately and clearly of tremendous benefit to the overall campaign.[174]

An airfield built by the 834th Engineer Aviation Battalion at St. Pierre Du Mont, France.

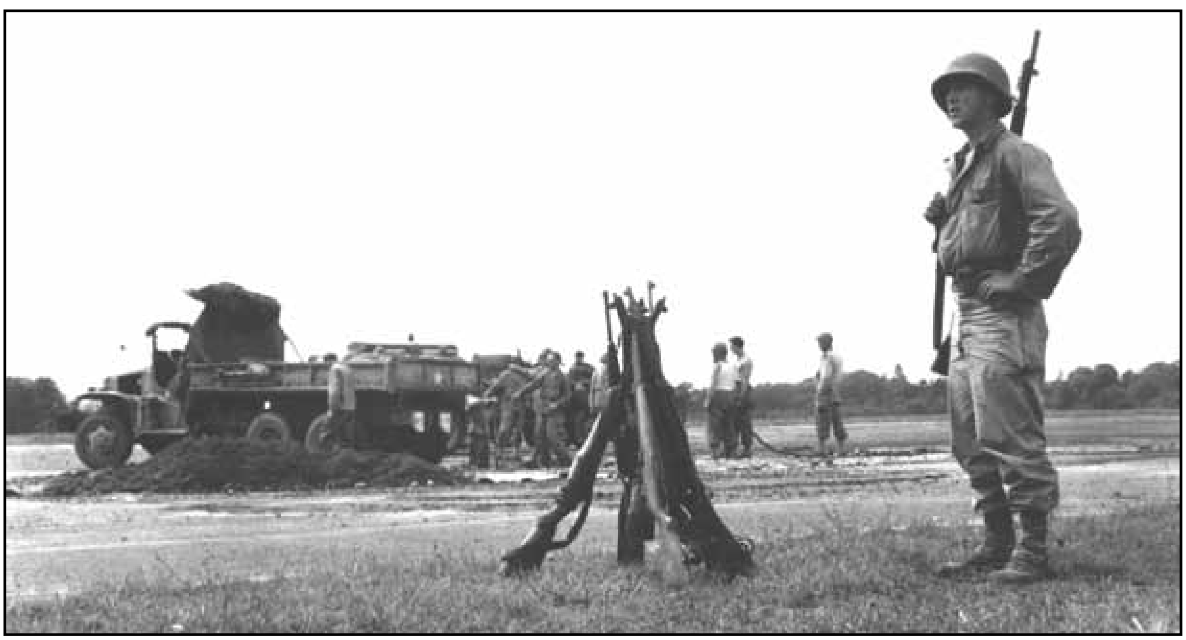
Members of the IX Engineer Command build an airfield using Hessian Matting in Normandy, France.

As more and more fields were constructed and demands continued to increase, it became obvious that providing continental airfields was more than just a IX Engineer Command problem—it was a theater air force problem. In October, Gen. Hugh Knerr established an Engineer Command (Provisional) at Headquarters U.S. Strategic Air Forces (USSTAF). In February 1945, IX Engineer Command was transferred from Ninth Air Force to USSTAF. This placed all U.S. aviation engineer units under one command and established the construction and maintenance of airfields as a responsibility of the theater air force rather than of Ninth Air Force. By then, there were about 23,000 aviation engineers in theater. Colonel Mayo, Army Air Forces Air Engineer, described the organization "as nearly ideal as is practicable for a theater of this nature."[175]

In March 1945, Ninth Air Force followed the advancing Allied armies across the Rhine River and to the Elbe. The greatest demand on aviation engineers from March to May 1945 was for supply and evacuation strips immediately behind the U.S. armies. In April, 13 engineer battalions worked east of the Rhine and another five worked west of the Rhine. They built 126 operational fields east of the Rhine, 76 of which were used exclusively for supply and evacuation. Developing fighter-bomber fields in Germany required large quantities of prefabricated surfacing materials, which had to be transported by truck since the German railroads could not be used.[176]

Overall, from D-Day until V-E Day, the activities of the aviation engineers were intimately entwined with those of the tactical air forces and with those of the ground troops. Supply and transportation posed continual problems, and aviation engineers struggled to keep up with the breakneck pace of the ground troops. Major adjustments were required to build more fighter-bomber fields than had been predicted and to base medium bombers on the continent. By V-E Day on May 8, 1945, the aviation engineers had constructed or reconditioned 241 airfields in France, Belgium, Holland, Luxembourg, and Germany. During the peak of the offensive, IX Engineer Command put an airfield into service every 36 hours. The easternmost field in Germany was constructed at Straubing in southeast

Brig. Gen. James B. Newman (right), Commander, IX Engineer Command, and Col. Karl B. Schilling, Commander, 1st Engineer Aviation Brigade, tour an airfield near LeMole, France, where a Butler Building is under construction.



With snipers in the vicinity of the Ville Coublay airfield in France, members of the 818th Engineer Aviation Battalion keep their weapons stacked nearby.

The Development of PSP

The steel landing mat used by aviation engineers was developed by the U.S. Army Corps of Engineers, in cooperation with industry, over a period of almost two years. Although elegantly simple in design, it turned out to be more complex to develop than originally anticipated.

In summer 1939, illustrations in European publications showed metallic grids being used to surface aircraft runways in France. The British were using an industrial wire mesh, stretched and anchored over a graded surface. The Chief of the Air Corps asked Carnegie-Illinois Steel to study specifications for the European technology and suggest modifications for production in U.S. shops.

The matter was turned over to the U.S. Army Chief of Engineers in fall 1939 for further study and development. A formal conference on the subject in December 1939 resulted in the submission of numerous designs and configurations for testing. The project was turned over to the Engineer Board at Fort Belvoir. In May 1940, the Chief of the Air Corps asked the Chief of Engineers to "exert every effort to secure something usable at once rather than strive for perfection at some later and determined date."

The landing mats had to have sufficient surface irregularity to provide skid resistance for large aircraft tires, yet had to be regular enough to allow vehicle and foot traffic. They had to be thick enough to ensure reasonable life under corrosive tropical conditions and to minimize kinking or

continued

Aviation engineers in Alaska construct a runway using pierced steel plank.

The Development of PSP *continued*

damage. Developers eventually hit on the concept of a bayonet hook and with removable clips that allowed for rapid assembly and disassembly.

Several conferences during 1940 and 1941 led to the conclusion that the plank did not need a solid surface and that sufficient bearing on the soil would be available if the plank were pierced with holes. Depressed rimmed holes would improve skid resistance. Holes would let rainfall seep into the ground and also permit drying of the subgrade. Vegetation could grow through to provide natural camouflaging.

In late spring 1941, the Chief of the Air Corps expressed satisfaction with the product and the Chief of Engineers arranged for production. Contracts were let, and over four million square feet were delivered in time for the Army maneuvers in the Carolinas in September and October 1941.

The universal planks that were finally developed were 15 inches wide and 10 feet long and weighed about 65 pounds per plank. They were one-piece stampings with interlocking and fastening devices along both edges. They were manufactured of low carbon soft steel sheets to facilitate straightening and reconditioning in the field. The soft steel eliminated the spring and bounce of harder steels. The final product was known as USS Air-Dek and received a coat of standard Army olive drab primer before being packed and shipped.

Prior to Pearl Harbor, only two manufacturers produced the mat. One year later, 29 plants were in operation. By the end of World War II, two million tons of PSP had been manufactured, enough to build nearly a thousand 150 x 5000-foot runways.

Sources: G. G. Greulich, "Pierced Steel Landing Mats for Airplane Runways," The Military Engineer, Vol 35, September 1943, 445-452; Dr. Ronald B. Hartzer, "Expedient Runway Materials of World War II," Air Force Civil Engineer, Vol 2, No 7, November-December 1994, 23; Richard K. Smith, "Marston Mat," Air Force Magazine, April 1989, 84-88.

A heavy equipment operator of the IX Engineer Command works on a fighter-bomber airfield in Germany.

> ***"I should say that the Aviation Engineers, along with the Combat Engineers, were among the most important people we had in the European War."***
>
> General Dwight Eisenhower,
> Talk to the 925th Engineer Aviation Group, Fort Richardson, Alaska, July 30, 1947

Germany. Near Pilsen, Czechoslovakia, elements of the 834th put an airfield into operation on May 8, 1945. On V-E Day engineers put the first strip in Austria into operation at Salzburg. Behind the aviation engineers was an array of stepping stones stretching westward to the coast of Normandy; a constellation of airfields, exactly as predicted by the unnamed briefing officer just prior to D-Day. With the campaign in Europe drawing to a close, all eyes turned toward the Pacific.[177]

Pearl Harbor and the Early War in the Pacific

When the Japanese attacked Pearl Harbor on December 7, 1941, the 804th Engineer Aviation Battalion was hard at work. The 803d had already arrived in the Philippines. No engineers died during the attacks but a considerable amount of engineering equipment was destroyed. As soon as the raids ended, aviation engineers began clearing and repairing the runways at Wheeler and Hickam. Hickam was especially important because it was the only airfield in the islands capable of safely handling B-17s. The 804th responded to Bellows Field as well. One of 12 B-17s that happened to arrive in Hawaii during the attack made an emergency landing there. Before day's end on December 7, contractors began lengthening the second runway to accommodate additional B-17s anticipated from the mainland in the next few days. Within five days, the runway was lengthened from 2,200 to 4,900 feet.[178]

The attacks at Pearl Harbor had the unexpected effect of reversing the defensive roles of the Army and the Navy. The islands had to rely mainly on land-based aircraft for protection. Maj. Gen. Clarence Tinker, commander of the Hawaiian Air Force, realizing the critical need for more protective and strategic airfields, ordered a speed-up of work on Oahu and on the outlying islands. On Oahu, engineers built 15 large bases within a year of Pearl Harbor, with revetments carved out of volcanic mountains, underground shops, miles of tunnels hewn in rock, tremendous aviation gas storage farms, and even a complete bomber runway nestled in a deep ravine for protection against enemy air action.[179]

Until the Battle of Midway in June 1942, when the threat of a Japanese invasion nearly was eliminated, engineers also focused on airfield denial to eliminate the potential for usable runways falling into enemy hands. Mine chambers were placed on the runways at Hilo Airport and Upolo Field on the island of Hawaii, but were not armed. On Kauai, they also installed mines at Burns Field and Barking Sands to prevent the Japanese from utilizing runways in the event of capture. After Midway, emphasis shifted to developing Hawaii as a base to support offensives and as a staging area to move troops westward.[180]

North Pacific

The attack on Pearl Harbor greatly diminished U.S. Navy presence in the northern Pacific. It was unknown whether the Japanese would attack Alaska and with what force. Defenses for Alaska and the Aleutians had to be strengthened as quickly as possible without detriment to work in other theaters. No new construction was contemplated in the Territory but the War Department directed expedited completion of approved and planned projects. Improvements were approved for Ladd, Elmendorf, Annette, and Yakutat Fields. Storage for aviation gasoline and for bombs and ammunition was programmed for all airfields, including those built by the CAA. Eleven aircraft warning stations were to be completed, and work was planned for an airfield and an Army post on Umnak in the Aleutians.[181]

Buildings under construction at the southern tip of Amchitka, Alaska, 1943.

On January 18, 1942, 64 officers and enlisted men from the 807th Engineer Aviation Company arrived at Umnak. Winter was not the best time of year for unloading supplies or for building an airfield. Equipment was moved in rough seas and bulldozer operators leveling the flying field were sometimes lost for hours in blinding snow storms. By mid-March, the entire 807th, then an aviation battalion, was working on the airfield. By March 31, a steel mat landing strip was completed and in use for the first time.[182]

On June 3, 1942, two Japanese aircraft carriers launched an attack on Dutch Harbor in the Aleutians, demolishing barracks and killing approximately 25 men. A repeat attack on June 4 caused considerable damage and claimed the lives of eight men from Company C of the 151st Engineer Combat Regiment. Meanwhile, two Japanese occupation forces approached the Aleutians. On June 7, one force landed on Attu, the most remote island in the chain. The other came ashore at Kiska on June 8.[183]

To meet the threat, the Joint Chiefs of Staff ordered airfields constructed on Atka and Adak and on St. Paul Island in the Bering Sea. The 807th Engineer Aviation Battalion amassed men and supplies at Unalaska and launched a “motley collection of some 250 craft, including tugboats, barges, fishing scows, and a four-masted schooner” for the five-day trip to Adak.[184] Under difficult conditions, they built a sand landing strip covered with 3,000 feet of landing mat to accommodate B-18 bombers. On September 13, 43 aircraft took off from Adak to bomb Japanese-occupied Kiska. A second runway was completed five days later.[185]

The 42d General Service Regiment completed a fighter strip on St. Paul, while Company A of the 802d Engineer Aviation Battalion prepared the landing field at Atka. Construction began on September 17 and a 3,000-foot steel mat runway was ready for operations two days after Christmas. In early 1943, the 813th Engineer Aviation Battalion helped build a fighter strip and bomber runway to preclude Japanese occupation. The site was near Constantine Harbor on the island of Amchitka, between Kiska and Adak.[186]

In May 1943, 29 engineers were killed during attacks and counterattacks between U.S. forces and the Japanese, who were entrenched on Attu Island. Afterwards, aviation engineers helped build an airfield on Attu and on Shemya Island. By early June, both islands featured fighter strips; the runway on Shemya later was lengthened for bombers. Although permanent expulsion of the Japanese effectively ended any immediate danger to the Aleutians and Alaska, work continued at Ladd and Elmendorf Fields on the mainland. Engineers built through the long Alaskan winter, encountering winds up to 100 miles an hour, heavy snow, and extreme sub-zero temperatures. Despite warnings that work would be impossible during the winter, the engineers prevailed. They poured concrete at minus 15°F and erected steel at minus 20ºF. After suffering frostbitten fingers and toes, the engineers adopted apparel from indigenous Eskimo culture to stay warm—boots were discarded in favor of three pairs of socks and locally-produced hide moccasins.[187]

Necessity became the mother of invention in coping with the extreme conditions. Building designs for airfield structures were modified to improve structural efficiency and conserve heat. Adaptations included increasing the thickness of structural members, installing additional bracing, applying diagonal sheathings, installing vapor barriers, and decreasing the distance between studs to combat the wind. Air exhaust systems were added to large heating units to eliminate downdrafts in chimneys, and vestibules or storm entrances were added to buildings as a buffer from the environment. Engineers learned construction for areas with permafrost and how to maintain freezing temperatures to retain load-bearing capacity.[188]

AUSTRALIA

Australia assumed great importance in Allied strategy after Pearl Harbor. The decision was made to establish a U.S. base of operations on the continent to supply the Philippines and to provide regional air support. Unfortunately, very little planning data existed for the region. Before the war, few envisioned the unique problems that confronted commanders in the Southwest Pacific. Immense distances complicated all facets of operations. Long distances were compounded by shortages of shipping to the area, production lags in the United States, and the priority of the war against Germany.

With a population of only seven million, mobilizing for war with Japan put a heavy strain on Australia's resources. In January 1942, Maj. Gen. George Brett of the U.S. Army Air Corps met with the Commonwealth Chiefs of Staff to discuss plans for strengthening the continent and establishing a base for operations against the Netherlands Indies and the Philippines. Gen. Brett's program called for the construction of air bases at Darwin, Brisbane, and Townsville. U.S. engineers counted on a measure of support from the Royal Australian Engineers, the Royal Australian Air Force Engineers, and from the Allied Works Council; however, the air base construction program was so ambitious that the United States assumed the bulk of the work. The limited manpower and resources of Australia's military and civilian construction industry already were engaged in the country's own extensive construction program.[189]

The 808th Engineer Aviation Battalion was assigned to build airdromes in the Darwin area. The battalion landed at Melbourne on February 2, 1942, just five months after it was activated. The battalion arrived with three dump trucks, two tractors, and haphazard training. The nearly 2,000-mile trip across the continent from Melbourne in the south to Darwin in the far Northern Territory was an odyssey in itself.[190]

At Melbourne the battalion boarded a special train to Terowie, the terminus of the broad gauge railroad. It transferred to the narrow gauge line that ran through the desert to Alice Springs, 1,000 miles to the north. The train operated at a top speed of 20 miles per hour. The railroad ended at Alice Springs and trucks carried the troops to Larrimah, 635 miles away. At Larrimah, troops boarded yet another train that comprised "cattle cars for personnel, small open cars for baggage, and a small wheezy locomotive which looked as though each hour of existence would be its last." On February 19, the battalion finally left the train at Katherine, the site of one of the new bomber fields. Deep in the Australian "Never-Never Land," the battalion felt completely isolated but knew it had an important mission to accomplish.[191]

The 808th's first assignment was to convert the civilian airdrome at Katherine into a medium bomber field and to locate sites for constructing new fields in the area. The engineers were severely handicapped by their lack of equipment but eventually obtained 11 cargo trucks and two old bulldozers at Darwin. Seven trucks were dedicated to keeping the battalion supplied with food and water. The remaining four trucks were used to haul gravel for the Katherine runway; the cargo trucks were emptied by hand. In addition to completing the runway, the battalion improved the road so that supplies could be trucked from Alice Springs. In the hot tropical sun, men only worked six hours a day and their efforts were periodically interrupted by Japanese bombings. Despite the challenging conditions, the Katherine runway was lengthened and surfaced with gravel within a month. They also began clearing sites for three more airstrips. During mid-1942, a series of fields were built along the rail line between Darwin and Birdum. The battalion departed for Port Moresby, New Guinea, in July 1942.[192]

On March 17, 1942, Gen. Douglas MacArthur and his staff from the Philippines reestablished their headquarters at Melbourne. Rather than wait for the Japanese to come to Australia, General MacArthur decided to meet them in the islands north of Australia. MacArthur planned a major hub at Port Moresby on the large island of New Guinea. He recognized aircraft would be essential for the movement of troops and supplies in the mountainous jungle terrain. Airfields and ports were prerequisites to success; the aviation engineers and the Seabees had to build these facilities from the ground up.[193]

General MacArthur anticipated an arduous drive to Japan accompanied by overwhelming engineering demands and an inadequate supply of resources. He insisted on the consolidation of all engineering resources under Brig. Gen. Hugh J. Casey, who had accompanied him from the Philippines. Aviation Engineers, regular Army combat engineers, and even Seabees worked on all types of engineering projects—runways, roads, and harbors. Although commander of Allied Air Force, Maj. Gen. George C. Kenney, complained bitterly, he could not persuade General MacArthur to change his mind about the consolidation. The requirement for two engineering organizations and logistical supply channels seemed a waste of resources. Engineers were a precious commodity in short supply. Their skills were essential, prompting General MacArthur to comment, "Because of the nature of air and amphibious operations, [this] is distinctly an Engineer's war."[194]

For Port Moresby to serve as the main air base for operations, a string of supporting airfields was needed along the coast of northern Queensland. Construction of these airfields fell primarily to the 46th Engineers, who sailed into Melbourne in late February. After two weeks training in Melbourne, the group began clearing and grading the three runways of a giant airfield at Woodstock near Townsville. The first airplane landed four days after construction commenced. Company A built a 2,500-foot steel mat runway at Torrens Creek southwest of Townsville in just five days, a possible record for the time. Companies B, C, and F built a third airfield at Reid River.[195]

Despite the challenges faced while building airfields in the bush country of northern Australia, the experience provided excellent training for the troops, who lived under the most primitive conditions and accomplished their work with minimal machinery. This was only a taste of the challenges to come.

South Pacific

Early in the war, the United States promised to strengthen Canton and Christmas Islands to reinforce defenses in the South Pacific. The U.S. also offered to support New Caledonia and Fiji, should Australia and New Zealand be unable to offer protection. In February 1942, task forces began arriving on the islands, accompanied by a sizeable force of engineers from the 810th and 811th Engineer Aviation Battalions.

New Caledonia was the linchpin in the South Pacific. By the end of 1943, the island had 12 Army airfields—five major airdromes and seven satellite fields. The 810th built an additional runway at Plaines des Baiacs and maintained a base to launch heavy bomber attacks against enemy forces moving south from the Japanese base in the Solomons. The 811th took over the airfield at Tontouta in early April 1942. It continued to rebuild, improve, and maintain the base until March 1944, assisted by the 873d Airborne Engineer Aviation Battalion and the 131st Engineers. Their efforts made Tontouta the most important base on New Caledonia and one of the most highly developed in the South Pacific theater. The 811th also built a fighter field further north at Bourake and completed additional work at Oua Tom.[196]

On December 28, 1942, the all-important South Pacific ferry route was declared officially open. Engineers constructing airfields at Canton Island, Tontouta (New Caledonia), and Nandi (Fiji) had achieved sufficient progress to accept heavy bombers. On January 12, 1943, the first flight of B-17s completed the route, stopping at the three fields and finally landing at Townsville, Australia. Pilots reported excellent runways. The airstrip on Christmas Island was added to the route in late January.

In May 1943, construction began to support a second southern ferry route via the Marquesas, the Society, and Tonga Islands. Those areas were deemed less likely to be overrun by Japanese forces. Meanwhile, the 822d and 828th Engineer Aviation Battalions worked with Seabees, Marines, and local natives to improve airfields and to reinforce the New Hebrides. Construction in Fiji was boosted by the 821st Engineer Aviation Battalion.[197]

Sites for airfields were sometimes selected with minimal information. Supply and equipment transport was incredibly difficult. These challenges made for unorthodox field engineering; standards for airstrips in the South Pacific were far different than those demanded in the European theater. The strips laboriously hewn out of jungles or laid on coral islands under enemy fire usually stood up to the pragmatic test of hard use.

Road construction frequently became a necessary adjunct to airfield construction. As a result, aviation engineers performed tasks bearing little relation to the air war. Establishing airfields also involved considerable associated building construction for hangars, shop facilities, and housing. The shortage of competent construction workers was a problem and engineers from all trades were sometimes pressed into duty. At one base undergoing expansion, General MacArthur observed a sea of carpenters erecting hangars, warehouses, and camp buildings. When he asked the commander where he got all the carpenters, the officer replied, "We gave each of the men a hammer and some nails. Anyone who hit his thumb more than once out of five times trying to drive a nail was eliminated. The rest became carpenters."[198]

Southwest Pacific

Army and Navy engineers, including aviation engineers, played a critical role in halting Japan's aggressive advance in the Southwest Pacific. They supported the slow, but sure, push of Japanese forces back across the island of New Guinea and into the Philippines. Engineers were so valuable that they accounted for 100,000 of the 700,000 troops in the Southwest Pacific by late 1944.[199]

In preparation for the drive to the Philippines, aviation engineers constructed massive basing complexes at Port Moresby, New Guinea. After firmly securing the Port Moresby area and Milne Bay on the southeastern tip of the island, engineer forces hop-scotched northwestward across New Guinea toward Wewak and Lae, then on to the Japanese stronghold at Rabaul on the island of New Britain. The offensive against Rabaul involved at least 24 squadrons, which would be based in New Guinea. An additional 12 airdromes with dispersals and sealed runways capable of taking heavy bombers were required.

The first engineers to arrive at Port Moresby were members of the 96th Engineer General Service Regiment. Together with Royal Australian Engineers, they patched and extended runways heavily damaged by the Japanese. Using hand tools, they scraped out extensions at both ends of the runway and created additional taxiways and hardstands. The group worked without specifications and without construction instructions; as usual, it had no equipment. The engineers were led by officers with little experience in airfield construction. The commander of Company D later described the operation as "building fields with our fingernails." Air raids were frequent and the men spent much time jumping in and out of slit trenches.[200]

A major airfield was needed near the southeastern end of New Guinea to intercept enemy ships rounding the tip of the island. MacArthur chose Milne Bay for the construction of a fighter field due to the availability of fresh water, coral gravel, and native labor. Company E of the 46th Engineers, augmented by 500 Australians, completed that first airfield. It soon came under attack by the Japanese.[201]

During summer 1943, engineers labored to meet Lt. Gen. (later General) George C. Kenney's request for yet more airfields to support the long campaign to conquer New Guinea. Construction of four fields near Port Moresby, four near Milne Bay, and another four near Buna on the northeastern coast of the island proceeded through the summer with help from the 808th Engineer Aviation Battalion. Conditions were much tougher than those encountered by the 808th in the Northern Territory of Australia. Dense growths of timber had to be cleared. Trees, more than 75 feet high with trunks two feet in diameter and large, deep roots, had to be chopped down or dynamited. The climate was abominable and hordes of mosquitoes made life miserable. Air raids were common and the engineers understandably became nervous and irritable from loss of sleep and personal discomfort.[202]

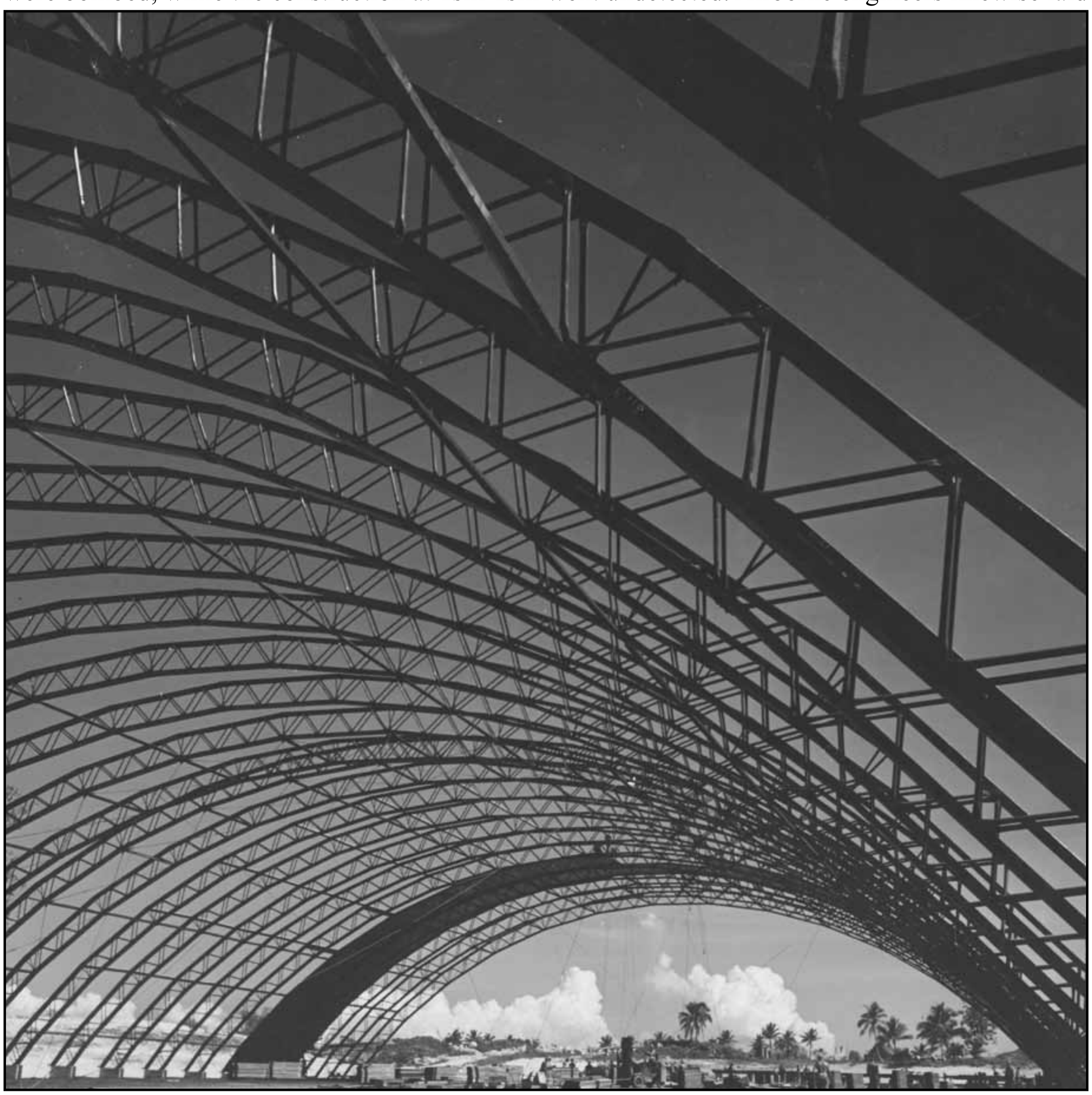
General Kenney ordered a total of nine fields and 227 revetments completed at Port Moresby by the end of August. Work also needed to be done to upgrade the fields for all-weather operations before the rainy season in November. General Kenney was frustrated with the speed of normal supply channels and began procuring materials for air force projects himself and flying them directly to his units in New Guinea. Outmaneuvering the supply process caused heartburn with the combat engineers but got their attention, and additional troops were assigned. Originally, engineers were called upon to build an enormous number of revetments on islands in the Southwest Pacific. The design called for hardstands with 15-foot earthen walls extending along three sides. Experience demonstrated that it took three D-8 tractors about three days to produce one such revetment. The structures were impractical to build and eventually were eliminated from many airdrome plans.[203]

During October 1943, great strides were made toward completing the New Guinea airfields but the strain of the pace and enormity of the task had taken its toll. Men and machines were wearing out. Engineer troops were tired and large numbers reported for sick call suffering with malaria, dengue, dysentery, and skin ailments. When the autumn rains began, downpours made fields temporarily unserviceable. Although the airstrips nearly were finished, the dispersals, hardstands, and access roads were not. General Kenney once again pressed for operational control of the 808th Engineer Aviation Battalion. He was unsuccessful but the ruckus he raised broke loose additional shipping to support the engineers.[204]

While construction was progressing in New Guinea, aviation engineers provided essential support to Marines engaged in the battle for Guadalcanal. Allies captured and repaired the Japanese field on Guadalcanal, which they named Henderson Field. The 810th Engineer Aviation Battalion then worked on a second bomber field known as Carney. It also built a strip on Espiritu Santo, which was operational during the early part of the battle. It then was used by bombers and reconnaissance aircraft and as a staging point for transports. Seabees completed a bomber field at Pallikulo, near the southeastern tip of the island; aviation engineers constructed a second one, with a 5,500-foot runway and two miles of taxiways, at nearby Pekoa. Both undertakings, conducted during the heat of battle on the island, were made difficult by frequent enemy bombings. In November 1942, the 822d Engineer Aviation Battalion joined the work, building hardstands, taxiways, and a control tower at Pallikulo. Organized resistance on Guadalcanal finally ceased in February 1943. Japan's southward expansion had been stopped and aviation engineers made a substantial contribution to the effort.[205]

Operation Cartwheel, the two-pronged campaign against Rabaul along the coasts of eastern New Guinea and western New Britain and through the Solomons, was launched in June 1943 and extended into the fall. U.S. and Australian troops were tasked with seizing a large portion of northeast New Guinea, which involved capturing Salamaua, Lae, Nadzab, the Markham Valley, Wewak, and Finschhafen. Meanwhile, the Sixth Army was to seize Kiriwina Island and Woodlark Island. Airfields were built at all sites. The engineers, including two airborne engineer aviation battalions, made major contributions to the success of the campaign.[206]

The airborne aviation engineers performed yeoman duty at Tsili Tsili. Aviation engineer Lt. Everette Frazier penetrated enemy territory on foot with an Australian officer and several natives. In the dense rain forest along the Watut River, they found an old field that could handle transport planes. With native labor, they cleared the field well enough for C-47s to land. Over a span of 10 days a company of airborne engineers transported their mobile bulldozers, graders, carryalls, and grass cutters to the site, where they graded a 4,200-foot runway for transports and began another 7,000–foot runway. Engineers also had the natives clear bogus airstrips in the vicinity to attract Japanese attention. The fake strips were bombed, while the construction at Tsili Tsili went undetected. Airborne engineers likewise laid



A hangar under construction at a 7th Air Force base in the Pacific.

out four usable airstrips in an area that collectively became known as Gusap. An all-weather runway eventually was constructed by January 1944 to support two fighter groups and a medium bombardment group.[207]

The Hollandia Operation took place in April 1944. It was the largest landing on the island of New Guinea. Engineers comprised 41 percent of the task force's troops. Of the 25,000 engineers at Hollandia, 7,500 were aviation engineers. After the invasion, four aviation engineer battalions improved the three captured Japanese runways and converted the area around Hollandia into a large air and supply base. The 931st Engineer Aviation Regiment and the 836th Engineer Aviation Battalion improved Japanese-built airfields in the Admiralty Islands and engaged in both combat and construction on Bougainville. In the Palau Islands of the Caroline group, the 1884th and 1887th Engineer Aviation Battalions hacked out a tangled jungle with 90 foot trees to build a 6,000-foot runway within striking distance of the Philippines. In the summer and fall of 1944, the Southwest Pacific theater had a total of 37 engineer aviation battalions in action.[208]

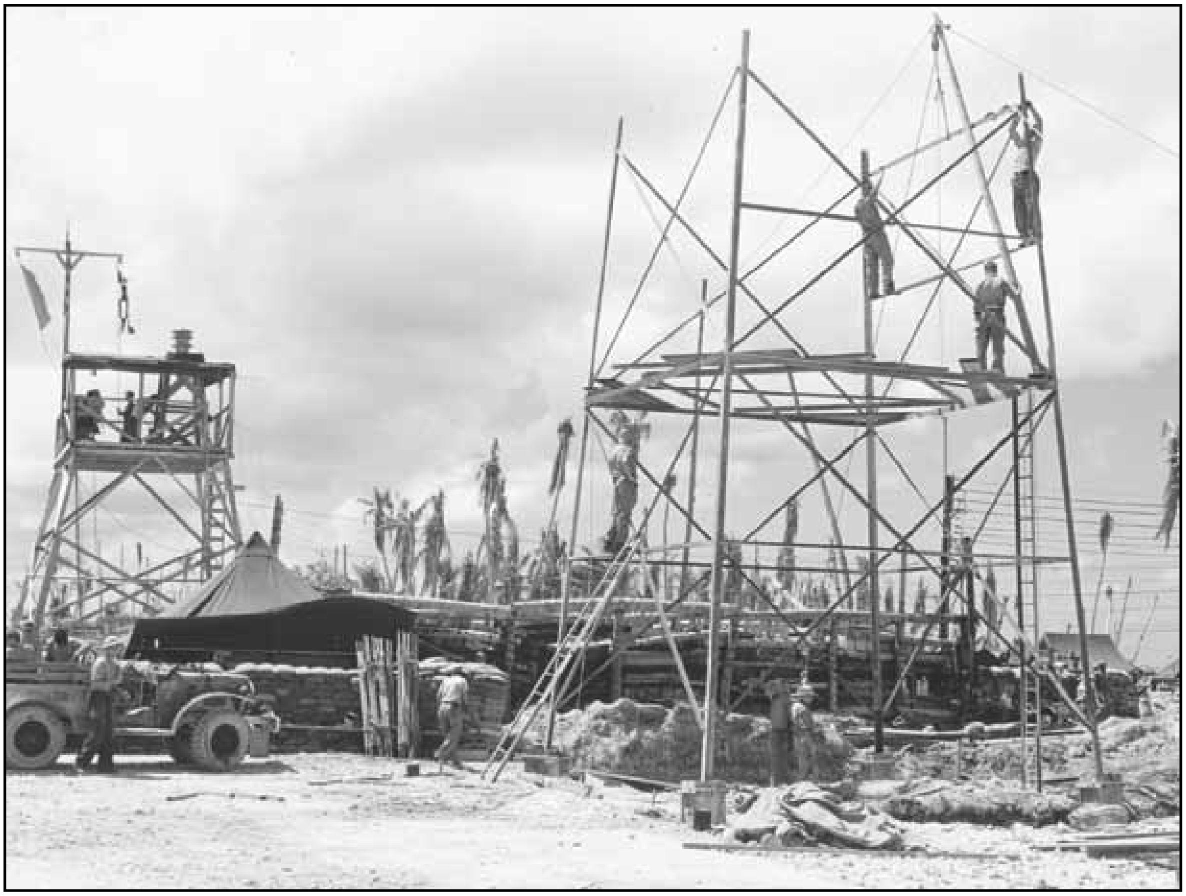
Central Pacific

In late 1943, offensives began to capture islands in the Central Pacific that the Japanese held for many years. The first objective was the Gilbert Islands, about 2,500 miles southwest of Hawaii. Critical preliminary operations were necessary before the islands were attacked, including occupation and construction of airfields on three small islands east and southeast of the Gilberts. The U.S. Marines and Seabees were sent to two of the islands, and the 804th Engineer Aviation Battalion was tasked to build an airfield on Baker Island. The field was complete within seven days, with 3,000 feet of pierced steel plank in place; it eventually was lengthened to 5,500 feet. The battalion built hardstands and parking mats to accommodate 25 fighters and 24 heavy bombers. Bombers launched from the field could reach the western Marshall Islands.[209]

An airfield on Makin Island, captured on November 20, was the next task for the 804th. In just over two weeks, the battalion conquered a swampy area in the interior, built a compacted sand runway surfaced with coral from the lagoon and Marston mat, and constructed a parallel coral taxiway. Fighter aircraft arrived four days later and the 804th continued to develop the site. The runway was extended to 7,000 feet and the engineers prepared hardstands, revetments, and some 40 prefabricated buildings. Makin was one of many coral atolls that engineers encountered on the road to Tokyo. The airfields on the little-known islands of the Central Pacific became stepping stones—in effect, stationary aircraft carriers—which allowed the campaign toward Japan to move forward.[210]

The Japanese retaliated violently to the seizure of the Gilbert Islands. Despite several air attacks, the U.S. grip remained secure. By mid-January 1944, preparations were well underway for further attacks against Japanese strongholds in the Central Pacific. These strongholds included the Marshall Islands where the 854th Engineer Aviation Battalion, known as "The Spearheaders," built a major airfield for four medium bomber squadrons on Kwajalein. The island-hopping campaign across the Pacific was a continuous struggle for air bases. Aviation engineers and Seabees worked together in healthy competition to provide airfields on newly-captured islands. U.S. aircraft often were flying missions from these new facilities before the Japanese were even aware that construction was underway. The bases were critical because they practically eliminated the need for vulnerable Navy aircraft carriers to linger in enemy-infested waters to support planes and eventually made possible the opportunity for bombers to directly attack the Japanese homeland. The nature of the Pacific campaign often made it difficult to anticipate the types of aircraft that would be assigned to particular airfields. As a result, an expedient runway for fighters was constructed first, followed by a second permanent runway, located parallel to the first, to support the largest anticipated aircraft.[211]

Carrying the war to the Japanese required a staggering logistical effort. Aviation engineers were faced with constructing airfields in the heart of virtually impenetrable jungles. Hangars, shops, and tank



Engineers construct a control tower on Biteo, Tarawa, January 1944.

farms were erected rapidly on coral atolls where every stick of lumber and every bar of steel crossed three thousand miles of water. Heavy equipment was off-loaded rapidly through pounding surf and without harbors. Potable water had to be secured on desert islands where fresh water was nonexistent and attempts to dig wells were complicated by sea water at a depth of four feet. Engineers demonstrated their ingenuity by solving these problems and many others, including the not-so-humorous task of felling coconut trees without being bombarded by coconuts.[212]

With the capture of the Marianas in summer 1944, one phase of the Pacific war ended and another began. While battles still raged in the Southwest Pacific, Seabees and aviation engineers landed on Saipan, Guam, and Tinian to begin construction. The bases they established supported B-29s assigned to the Twentieth Air Force to bombard the Japanese homeland. Five giant airfields were built in the Marianas in late 1944 and early 1945 to support the heavy bomber fleet: two on Guam, one on Saipan, and two on Tinian. Aviation engineers constructed the airfields on Guam and Saipan, while Seabees built the runways on Tinian. In all, these airfields supported five B-29 wings, totaling some 720 aircraft. Among that fleet were the *Enola Gay* and *Bockscar*, the aircraft used to drop atomic bombs on Hiroshima and Nagasaki.[213]

Lt. Gen. Millard Harmon, commanding general of the Army Air Forces for the Pacific Ocean Areas, was the driving force behind the program. He convinced General Arnold that the Pacific Islands Area, only 1,500 miles from Tokyo, was the area to launch early mass bombing on Japan. He constantly argued for higher priorities in shipping and construction. He impressed upon General Arnold his belief that the engineering and logistical problems could be solved in time for five bomb wings to be established and operating from the Pacific islands before the Philippine campaign was completed.[214]

Constructing with Coral

Aviation engineers became experts at constructing roads and runways out of coral, which was the only material readily available on the coral atolls of the Pacific. Coral had a hardness that sometimes required mining operations using dynamite. Once quarried, engineers used sheepfoot rollers to break down pieces sufficiently and fill interstices. After it was spread, sprinkled lightly with water, and rolled several times, coral produced a smooth, hard runway capable of withstanding heavy operational loads. Coral had to be kept wet continuously to prevent it from becoming dusty and blowing away.

Roads and runways subjected to heavy use were surfaced with asphaltic concrete. In some cases, engineers first applied a binder or sprinkled the coral and immediately paved over it. In other cases, they rolled a surface until it was hard and tight and then applied a coating of oil, which bound the surface temporarily and made it waterproof. Such runways had the disadvantage of requiring considerably more maintenance.

Sources: Karl C. Dod, *United States Army in World War II, The Technical Services, The Corps of Engineers: The War Against Japan*, Office of the Chief of Military History, United States Army, Washington D.C., 1966, 385-386; Capt. L. Dean Waggoner and 1st Lt. M. Allen Moe, "A History of Air Force Civil Engineering Wartime and Contingency Problems from 1941 to the Present," Thesis 85S-23, Air University, AFIT, WPAFB, Ohio, September 1985, 72-73.

Original plans called for most of the airfields to be operational by October 1944. Japanese resistance delayed the construction schedule somewhat and delays were compounded further by weather during the rainy fall months. On Saipan, the schedule partially was met, with a temporary airstrip in place by August. Five 800-man aviation engineer battalions—the 804th, 805th, 806th, 1878th, and 1894th—labored around the clock for two months to extend the strip to 8,500 feet and widen it to 200 feet. The first B-29 arrived in theater on October 12. Tropical rains pummeled the engineers throughout the summer. For months they were without fresh food. Roads from the coral pits virtually became impassable; men and equipment were diverted to construct a hard-surface road to keep trucks in service. Hard coral formations just beneath the surface made blasting necessary for all cuts. In October, a typhoon threatened the newly-arrived bombers. Aviation engineers devised rings in their welding shops to anchor the aircraft. In the end, their persistence was rewarded. On November 24 the first bombers took off from Saipan for a successful raid on Tokyo.[215]

Construction of Depot Field on Guam began in September, with an estimated completion date of November 1. Torrential rains and the diversion of construction units slowed the work. The extraction of coral on Guam was just as difficult hard as it had been on Saipan. Despite the challenge, a 7,000-foot runway was operational by November 10. The first of four runways at North Field on Guam was completed in early February 1945 and the first combat mission was flown the same month. The remaining runways were not completed until May, June, and July, in time to host some of the final missions of the war.[216]

Airdromes on Tinian were built by the 6th Naval Construction Brigade. The first runway at West Field was completed in March and the second in April. By the end of April, taxiways, hardstands, and storage facilities for fuel and bombs were substantially ready. The principal tenant was the 313th

At East Field, Saipan, a seven-ton D-4 tractor clears the jungle to provide parking space for P-51s.

As P-51s fly overhead, engineers widen the south end of Number 1 airstrip on Iwo Jima, March 1945.

Bombardment Wing, which crowded 122 B-29s onto the small island. The 509th Bombardment Group, which was charged with delivering the atomic bombs, moved to the island in June and July. On July 20, the group began a series of combat strikes over Japan to familiarize crews with the target areas and tactics for the final missions.[217]

Runway Construction for Heavy Bombers

Designing runways to accommodate the giant B-29 heavy bomber was among the most difficult technical missions accomplished by the U.S. Army Corps of Engineers during World War II. The long-range bomber had a gross weight of 140,000 pounds when fully loaded and required smooth, finished runways of asphalt or concrete 8,500 long and 200 feet wide. To complicate matters, runways often had to be constructed under combat conditions in remote regions of the Pacific and China-Burma-India theaters. Depending on the availability of resources, specifications for both rigid (concrete) and flexible (bituminous) pavements were employed.

B-29 runways on Tinian Island

Design standards for such runways were non-existent prior to World War II. The heaviest pre-war aircraft weighed only 25,000 pounds and standard highway methods served well enough in pavement designs. As late as 1939, the Construction Division of the Quartermaster Corps had not developed detailed engineering criteria for paved runways. When the U.S. Army Corps of Engineers inherited the aircraft program from the Quartermaster Corps in late 1940, it also inherited a complex and urgent technical problem that required significant research.

The U.S. Army Corps of Engineers consulted leading experts in pavement design at the Civil Aeronautics Authority, the Public Roads Administration, the Portland Cement Association, the Asphalt Institute and in the academic world. In January 1941, it hastily compiled a manual, Design of Airport Runways, covering grading, drainage, runway layout and design of both rigid and flexible pavements. At the same time, the Waterways Experiment Station (WES) at Vicksburg, Mississippi mobilized a crash research and testing program of impressive proportions. WES also assembled data on rainfall rates in prospective battle zones and prepared reports for the Joint Chiefs of Staff on the bomber base potential of various Pacific Islands.

Lt. Col. James Newman, Jr., the district engineer serving Wright Field in early 1941, conducted a series of experiments on reinforced concrete. Similar tests were conducted at Langley Field, Lockbourne Field and Dayton Municipal Airport. The WES test site in Mound, Louisiana, conducted studies of base course requirements under steel planking and Hessian mat.

The Boeing plant personnel at Marietta, Georgia, also participated in the runway development program. At a test section established near the plant, they experimented with a variety of materials

continued

Runway Construction for Heavy Bombers *continued*

never before considered for very heavy bombers. These included old fashioned hand-set Telford stone, water-bound macadam, and sand-clay and sand-asphalt bases surfaced with bitumen or steel landing mat. Based on results, blueprints were prepared and shipped directly to units overseas.

Thus, by the time Boeing began delivering the first B-29s in July 1943, stateside as well as deployed engineers had the specifications they needed in hand. The training of very heavy bombardment groups in the United States took place at four fields near Salina, Kansas. By late spring 1945, operations had expanded to 40 major air bases. Overseas engineers constructed or extended numerous runways to accommodate B-29 operations in the Pacific and CBI theaters.

Sources: Lenore Fine and Jesse A. Remington, *United States Army in World War II, The Technical Services, The Corps of Engineers: Construction in the United States*, Center of Military History, U.S. Army, Washington, D.C. 1989, 446-447, 614-616, 641-643; Anthony F. Turhollow, "Airfields for Heavy Bombers," in Barry W. Fowle, ed., *Builders and Fighters: U.S. Army Engineers in World War II*, Fort Belvoir, Virginia, U.S. Army Corps of Engineers Office of History, 1992, 207-214; "Specifications for B-29 Air Bases," *Aviation Engineer Notes*, No 34, April 1945.

Aviation engineers construct steel frame for the roof on a Quonset hut on Saipan,

An aviation engineer pulls a sheepsfoot roller during construction of an airfield on Saipan.

Rollers smooth a runway surface as a B-24 Liberator lands following a long, overwater strike. This black-topped airstrip gave an all-weather capability for the aircraft in the Bonin Islands.

Engineers on Saipan Respond to Japanese Attack

Aviation engineers building the airfields on Saipan contended with many challenges, including enemy attack. On November 24, 1944, the first flight of B-29 heavy bombers took off from Saipan to conduct a successful raid on Tokyo. Retaliation was inevitable and, three days later, Japanese Zeros bombed Isley Field on Saipan during the daylight hours. Engineers from the 804th Engineer Aviation Battalion shot down one enemy airplane as it strafed their bivouac area.

On November 29, the Japanese returned and caused considerable damage. They struck a B-29 being loaded for a 0515 takeoff. Bombs and burning wreckage were strewn all over the field, together with the small anti-personnel fragmentation bombs dropped by the Japanese Zeros. Brig. Gen. Haywood Hansell, commander of XXI Bomber Command, gave an eyewitness account of the event in a letter to General Arnold, describing it as “the most violent explosion I have ever seen.”

General Hansell’s praise of the engineers was effusive. “Our engineers and our fire people did a job that would warm your heart—the engineers in particular I cannot speak too highly of. They took their large equipment, the big bulldozers and scoops and went to work immediately on the flaming bomber and gas truck in spite of personnel bombs and exploding ammunition. They piled the debris of the bomber into two heaps and pushed dirt on it. Later they drove their 20-ton bulldozers over these flaming heaps. The flames came up through the tractors and all around the drivers but it didn’t stop them.”

By 0230 the fires were under control, and the engineers were “cleaning up the mess.”

Sources: Karl C. Dod, United States Army in World War II, The Technical Services, The Corps of Engineers: The War Against Japan, Office of the Chief of Military History, United States Army, Washington D.C., 1966, 518; Wesley Frank Craven, and James Lea Cate, eds., The Army Air Forces in World War II, Vol 7: Services Around the World, Office of Air Force History, Washington, D.C., 1983, 305.

Philippines

Japanese fighters and bombers struck the Philippines on December 8, 1941, just hours after the attack on Pearl Harbor. Engineers assigned to the 803d Engineer Aviation Battalion were deployed, reinforcing engineers who were straining to build heavy bomber bases and strengthen fortifications. The 803d had just completed a five-month journey from Hawaii to the Philippines, arriving only weeks before the Japanese attack. The Japanese inflicted the greatest damage at Clark and Iba Fields. The engineers immediately responded to repair the runways there and at Nichols Field. They also accelerated completion of Del Carmen and O’Donnell Airfields.[218]

Once the Japanese invasion started in earnest, the aviation engineers found themselves heavily involved in the fighting. They served as infantry troops during the defense of Bataan and turned back a Japanese suicide attack. Two companies of the 803d became prisoners of war with the surrender of Bataan on April 9, 1942. Company A of the 803d reached Corregidor, where they kept Kindley Field in operation, in the hope that aircraft would arrive. Planes never came. The remnants of Company A were among the last Americans to surrender at Corregidor on May 6, 1942. At least 20 men from Company A and the company commander lost their lives in the fighting.[219]

Combat engineers from the 61st, 81st, and 101st Battalions composed the Visayan-Mindanao force during the battle for the southern Philippines. Most eluded the enemy by retreating into the mountains of the southern islands. They helped organize guerilla forces that destroyed roads and bridges, making overland transport by the Japanese almost impossible. They also gathered intelligence, which was

Frantic activity at a Tacloban airfield as aviation engineers continue their work.

forwarded to General MacArthur in Australia. The guerillas still were harassing the enemy when U.S. troops returned to the Philippines late in 1944.[220]

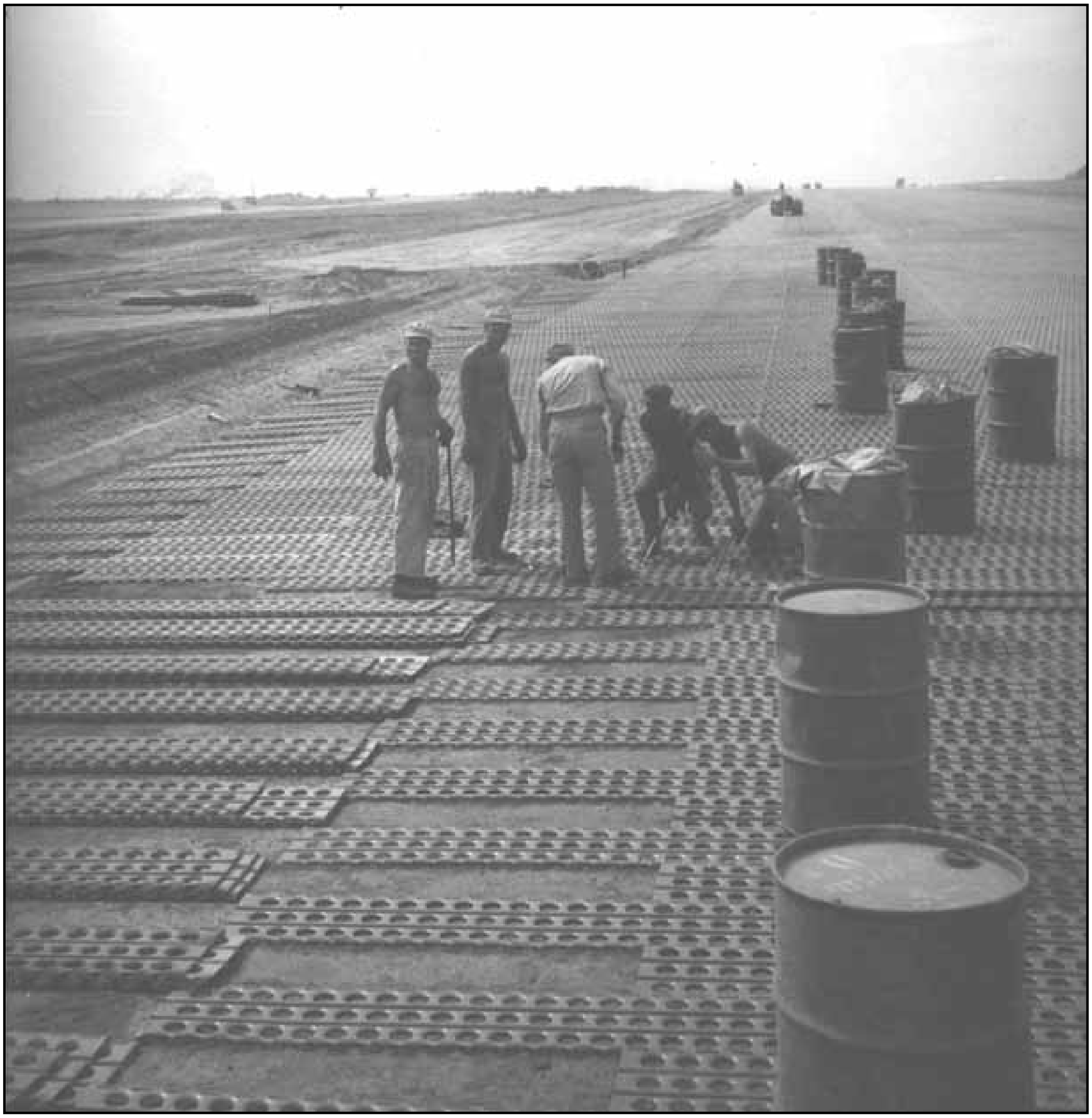
The return to the Philippines necessitated the capture and rehabilitation of numerous Japanese airfields. New airfields were constructed on Wakde Island, Biak, Vogelkop, Owi Island, Morotai, Kamiri, and other islands stretching from the coast of New Guinea to the southern Philippine islands. Campaigns were launched throughout June and July 1944. Stiff Japanese resistance, rough terrain, heavy vegetation, worn equipment, and delays in receiving equipment made the engineers' job difficult. The Japanese airstrips on Noemfoor and Kamiri were in shambles. At Kamiri, the engineers resorted to dragging lengths of Japanese railroad rails behind trucks to smooth ruts and used abandoned rollers to compact the airstrip. The 1874th Engineer Aviation Battalion worked around the clock to lay a coral surface in order to open the airstrip for transport aircraft by mid-July.[221]

The landing at Morotai turned out to be one of the most difficult in the Southwest Pacific. What appeared on aerial photographs to be beaches of white sand or coral proved, instead, to be three feet of gray mud. The engineers built ramps and piers into the water to offload their equipment ashore. Within 40 days, three engineer aviation battalions and two Australian construction squadrons constructed a fighter runway and a bomber runway on Morotai. They also completed 90 percent of a second bomber strip and storage for 40,000 barrels of aviation gasoline.[222]

In the steady northward progression from New Guinea to Leyte, Mindoro and, finally, to Luzon, the Southwest Pacific Air Forces bypassed substantial enemy garrisons. Air attacks reduced the enemy's capacity to pose a serious threat to Allied operations and effectively isolated enemy forces from the Japanese homeland.[223]

The 1944 campaign against Leyte unfortunately coincided with the rainy season and the months most prone to typhoons, October and November. Leyte was mountainous and heavily vegetated, except for two principal lowlands marked by streams and numerous rice paddies. Engineers had little time to plan and there were an insufficient number of bridging units and equipment available to conduct bridging operations to support construction. Despite these difficulties, the assault was launched on October 19 with the goal of capturing Tacloban airdrome and four fields in central Leyte as quickly as possible.[224]

At Tacloban, the 1881st Engineer Aviation Battalion and two other units bivouacked on the peninsula alongside the runway to be near their work. For five days they pumped coral from the ocean floor to establish a sub-base solid enough to support steel mats for a 7,000-foot runway, in spite of hundreds of aerial attacks. One night they withstood 71 separate passes by enemy aircraft. Air support virtually was non-existent because of the major naval battle raging off Leyte. Many U.S. aircraft attempted crash landings; most planes cracked up on the loose coral and sand of the runway. The engineers bulldozed 25 wrecked airplanes into the ocean. Recruiting Filipino laborers was difficult owing to



Engineers of the 1913th Engineer Aviation Battalion lay steel matting at Clark Field, Luzon, Philippine Islands.

their reluctance to work under air attacks. Working around the clock with lighting generated on site, the engineers managed to ready the runway for fighters on the sixth day of the battle.[225]

Thirty-five inches of rain fell during the first 40 days of fighting on Leyte. The island's roads disintegrated rapidly under military traffic, severely impeding supply routes. Construction of airfields was restricted to Tacloban and Dulag. The air forces insisted on the completion of all four airfields in central Leyte, but conditions made meeting their request impossible. With great difficulty, the engineers finally were able to open the airfield at Dulag on November 18. They installed 4,100 feet of landing mat. Headquarters, Sixth Army agreed to move from the relatively dry site that they occupied near the town of Tanauan, one of the few other locations suitable for an airfield. Three aviation engineer battalions completed a second steel mat runway by mid-December, thus removing a major obstacle in the campaign against Mindoro and Luzon.[226]

During the landing at Mindoro, the 1874th Engineer Aviation Battalion worked with an Australian airdrome construction squadron to complete two B-24 airfields; both were ready for emergency use by December 25, 1944. Japanese kamikaze pilots launched a week of attacks in an attempt to deny the Allies use of the island; these attacks resulted in significant losses in stocks of supplies, equipment, and rations. Nevertheless, Fifth Air Force had made a commitment to bomb Formosa during operations on Okinawa and continued to move air units forward as quickly as the engineers completed work. The first 7,000-foot runway was ready by the end of January. Without steel matting, engineers improvised a clay and gravel subsurface and coated the runway with gravel chips shot with asphalt. Sufficient PSP was available to build a heavy bomber strip at Murtha Field, which opened in early March. Both bases were heavily used during operations in the Philippines in summer 1945.[227]

The landing on Luzon began on January 9 at Lingayen Gulf. The 836th and 1879th Engineer Aviation Battalions had seven days to build a 5,000-foot steel mat runway before Navy aircraft carrier support was withdrawn. With the help of 400 Filipino civilians, they met the goal and began work on a second runway two miles south near the town of Dagupan. They were assisted by the 828th and 864th Engineer Aviation Battalions. The 1876th Engineer Aviation Battalion built another strip near the town of Mangaldan.[228]

The airfields constructed for Far East Air Forces at Lingayen and Marcelino were adequate for the assault campaign on the Philippines, but were not adequate to support continued operations of any magnitude. As the Allies made the drive down the Central Plains to Manila, they secured five all-weather fields—Clark, Porac, Floridablanca, Nichols, and Nielson. Clark and Floridablanca had dual heavy bomber runways capable of being extended for B-29s. Work began on all fields early in March, and they were practically complete in May.[229]

Many other requirements demanded attention besides airfield construction on Luzon. Fourteen of the 36 aviation engineer battalions concentrated in the Philippines were commandeered to work on other projects, primarily bridge building and repair. By the end of the Philippines campaign, over half of the work performed by aviation engineers was estimated as construction unrelated to the air forces. The conquest of Luzon further accelerated the Japanese retreat and paved the way for the Allied attacks on Formosa, enemy airfields on the China coast, and, ultimately, on Iwo Jima and Okinawa.[230]

China-Burma-India

Although the war against Japan was fought and won primarily in the Pacific, the United States also provided significant assistance via India and Burma. The goal was to keep China in the war and to prepare for both ground and air offensives against enemy forces in eastern China and Japan. With the Japanese controlling most of Burma by the end of May 1942, the Allies launched a campaign to build seven airfields for transport aircraft. The airfields, primarily proposed in Assam Province in northeastern India and Yunnan Province in southwestern China, were intended to support airlift operations over "The Hump" of the Himalayas. A series of bomber fields also were planned across northern India to defend the sub-continent. Supplying the airlift to China meant building the most extensive military pipeline system ever constructed across 2,000 miles of hostile territory.[231]

At the Quadrant Conference in Quebec in August 1943, the United States and Great Britain strategized to capture the northern part of Burma to increase flight safety over The Hump and to restore overland communications between India and China. Aviation engineers, under Army Air Forces control, supported the campaign in Burma and developed the important complex of bases around Myitkyina. Once northern Burma was secure, effort shifted to construction of the Ledo Road. The road was planned to extend from northeastern India across northern Burma and intersect with the Burma Road, which linked Burma with China. Col. Lyle Seeman became the first theater air engineer stationed at headquarters for the CBI Air Service Command near Calcutta. He was responsible for support to the Tenth Air Force in India and Fourteenth Air Force in China.[232]

The airborne aviation engineers played an important role in the pacification of northern Burma. On December 25, 1943, the 900th Airborne Engineer Aviation Company was flown to Shingbwiyang, beyond the head of the Ledo Road. It proceeded to construct an airfield behind enemy lines. In March 1944, members of the same unit accomplished a difficult and stunning feat. They descended by gliders at night deep into enemy territory to build five airstrips. Construction was undertaken in support of commando operations led by Col. Philip Cochran and British Gen. Orde C. Wingate. General Wingate led specially-trained guerilla forces called Chindits; they included British, Gurkha, and Burmese guerrillas. Loaded on the gliders were four bulldozers with attached blades, two scrapers, a grader, a jeep, and hand tools. The equipment was smaller than typical machinery, making it easier to transport.[233]

The heavily-laden gliders were towed over the 7,000-foot-high mountains of the Indo-Burmese border. Due to their weight, the gliders were forced to approach the landing clearing at high speeds. Unfortunately, what previously had been identified as a grassy clearing during air reconnaissance turned out to be crosshatched with ruts from logging operations. The ruts tore the landing gear off some of the gliders and pile-ups occurred due to the numbers of craft landing. Capt. Patrick Casey, commander of the 900th Engineers, was killed and about five percent of the landing force was lost. A bulldozer and a scraper were wrecked. Nevertheless, the engineers leveled the clearing as rapidly as possible. By the next night, approximately 70 C-47s safely landed to deliver troops and supplies on the runway, which was already equipped with lights, radios, and radar. That same night, another detachment of the 900th successfully prepared another landing strip 50 miles further south. General Wingate's brigades were sent to two fields to push forward and dynamite the Burma Railway.[234]

On March 21, a third airborne engineer operation established a landing strip for the Chindit forces 80 miles southwest of Mogaung. The engineers raced against time to construct the landing field for land assault forces before the Japanese could respond to the incursion. The engineers won the race

Airborne aviation engineers unload "Lucille," a specially designed tractor, from a C-47 at Tamu, Burma.

An airborne aviation engineer uses a tractor he just unloaded from one of the Waco gliders in the photo.

by two hours, in just enough time for Chindit guerrillas to intercept the approaching Japanese. Part of their efficiency was due to the fact that the airborne engineers were trained in loading, lashing, and unloading all of their own equipment into gliders and aircraft. Airborne engineer units received their training at Westover Field, Massachusetts; Fort Benning, Georgia; and at the Airborne Center at Camp Mackall, North Carolina. They were expected to be able to march continuously for 15 to 20 hours at an average rate of six miles an hour and to be ready for combat at the end of such marches. They were capable of sustained effort and prolonged physical exertion on limited rations, in addition to their engineering skills. They received their final training at Troop Carrier Command airfields, where they trained with the aircraft and personnel who transported them in theater.[235]

On May 17, 1944, Company A of the 879th airborne engineers launched an operation to build airstrips near Myitkyina. All of the gliders crash-landed but only four men were hurt. Under Japanese attack, the engineers rallied and fought back. They successfully scraped out airstrips, which remained in service throughout the summer. By early June, all of the 879th were at work on the airfield. Casualties during the fighting were heavy and approximately 150 engineers were killed. The Tenth Air Force eventually deployed four regular aviation engineer battalions with heavy equipment to the airfields. They cut equipment as large as D-7 caterpillar tractors into pieces in order to fit it into C-47s; the tractors were welded back together on the other end. Myitkyina became the only area in the CBI Theater where the aviation engineers worked in strength under air force control.[236]

Although the airborne engineers achieved great successes in Burma, other campaigns were not as positive. Theater commanders tended to doubt their reliability, primarily because of the inefficiency of their light equipment. Some of the airborne troops began to regard themselves as orphan units. Late in 1944 most of the airborne battalions turned in their undersized equipment for heavier machines or were absorbed into conventional battalions.[237]

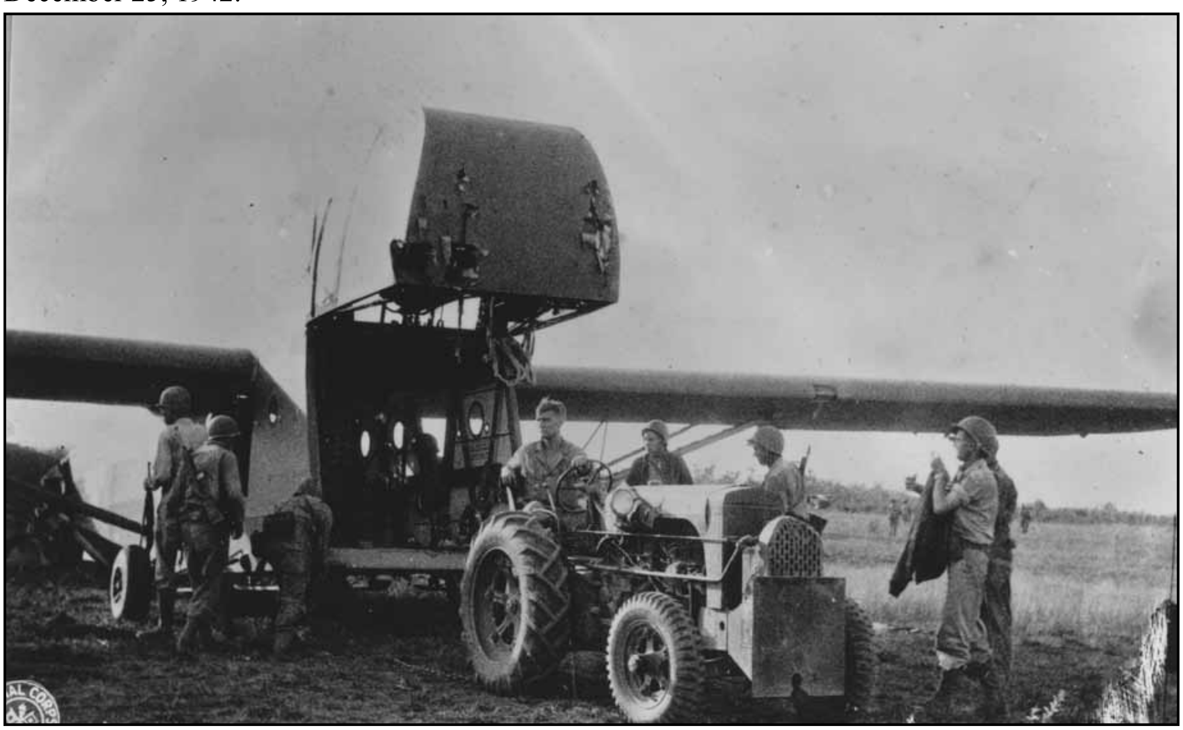
Early construction of airfields in India was conducted by native laborers under British supervision,

> ***"[Gen Orde] Wingate and I think you should tell Godfrey that his airborne engineers are superb, repeat superb."***
> Air Marshall John Baldwin, *Aviation Engineer Notes 24, Jun 1944, page 7.*

but the United States was soon called upon to provide logistical and construction support. In December 1943, Brig. Gen. Stuart Godfrey, the Air Engineer in Washington, was transferred to the CBI theater to supervise construction of B-29 bases in the Bengal area for the Tenth Air Force. He also kept tabs on construction in China under the auspices of the engineering staff at Fourteenth Air Force, all part of Operation MATTERHORN.[238]

The 853d, 879th, 1875th, and 1877th Engineer Aviation Battalions enlarged and improved five existing airfields in the flatlands west of Calcutta, using mostly borrowed equipment. The 853d experienced tragedy during its transfer from Algeria to India. More than half the battalion was lost when an aerial torpedo launched by a German airplane struck its ship, the *HMT Rohna*, near Sicily on November 26, 1943. In mid-April 1944, the 1888th Engineer Aviation Battalion arrived, along with more machinery, and progress on the fields in the Bengal region accelerated. Soon engineers were building or maintaining some 45 airfields in India. In addition to runway construction, engineers erected hangars, housing, and operational buildings salvaged from the Mediterranean theater. The first B-29s left for Bangkok on June 5 to bomb railway shops, and the airdromes were fully complete by September.[239]

Five African-American aviation engineer battalions—the 823d, 848th, 849th, 858th, and 1883d—arrived in theater during 1942 and 1943. Sixty percent of the 15,000 U.S. troops assigned to construction of the Ledo Road were African-American. The 45th Engineer General Service Regiment, like the 823d Engineer Aviation Battalion, previously worked on airfields in Assam and elsewhere in India. By April 1945, 111,012 African-American engineer troops served overseas, including more than 50 separate Aviation Engineer battalions. The 823d Engineer Aviation Battalion was dispatched to the critical but remote Assam region in July 1942. The battalion helped with airfield construction before joining combat engineering battalions in constructing the Ledo Road.[240] Begun by the British in early 1941, Gen. Joseph Stilwell's plan called for the United States to resume work on the road, which began on December 25, 1942.[241]



Glider-borne aviation engineers use their equipment to haul the glider off the airstrip at Myitkyina in Burma.

Airborne aviation engineers work on the Myitkyina airstrip for use by 10th Air Force pilots.

Construction of the Ledo Road was one of the great engineering feats of the war. The rudimentary road ran east from Ledo, through the Patkai Mountains on the Burmese border to Shingbwiyang, then veered south to the towns of Myitkyina and Bhamo, and east from Bhamo to the Burma Road. The route spanned a total distance of 500 miles and ran through rugged country from Ledo to Myitkyina. Approximately 275 miles extended through an area of largely uncharted jungle and through some of the most difficult terrain in the world. Weather posed a further challenge. During the monsoon season from May to October, northern Burma received an average of 140 inches of rain in the mountains and 120 inches in the valleys.[242]

Getting to India and then to the construction site was a rigorous journey in itself. With no time to bring new battalions from the United States, General Arnold recommended that the War Department divert construction units from previous assignments. Battalions from North Africa traveled overland across Africa, boarded ships to Bombay, and then journeyed for days on slow trains across India to the Bhramaputra River. Steamers took them up river to a rail connection to Burma.[243]

The 823d Engineer Aviation Battalion and the 45th Engineer General Service Regiment first built warehouses, barracks, hospitals, and base roads at Ledo. By New Year's Day 1943, the engineers were making good progress on the road toward the Patkai Mountains. The 823d cleared a road trace and the 45th followed, completing grading and applying gravel or crushed rock to stabilize the road. By February, they reached the Pangsan Pass, where they were forced to increasingly rely on explosives; they pushed on for the Burmese border. As the lead bulldozer crossed into Burma on February 28, the 823d and the 45th Engineers erected a sign—"Welcome to Burma, This Way to Tokyo."[244]

In March, the engineers were joined by the Chinese 10th Independent Combat Engineer Regiment. March brought early monsoon rains; by April the monsoon was in full swing. Equipment skidded off the road and even pack animals could not be used to transport food and gasoline to the road head. Resupply was accomplished by airdrop. During the early monsoon season, March to May, the road advanced only four miles. The engineers were plagued by equipment maintenance problems, shortages of spare parts, and lack of trained supply personnel.[245]

THE AIRBORNE ENGINEER'S SONG

(Sung to the tune of "The Man on the Flying Trapeze")

Oh, once I was happy but now I'm Airborne
Riding in gliders all tattered and torn
The pilots are daring, all caution they scorn
And the pay is exactly the same.

We glide through the air in our flying caboose
Its actions are graceful, just like a goose
We hike through the jungles 'til joints have come loose
And the pay is exactly the same.

We glide through the air in a tactical state
Jumping is useless, it's always too late
No chute for the soldiers who ride in a crate
And the pay is exactly the same.

We fight in fatigues, no fancy jump suits
No bright leather jackets, no polished jump boots
We crash land in gliders without parachutes
And the pay is exactly the same.

Once I was happy and now I'm a dope
Riding in gliders attached to a rope
Safety in landing is only a hope
And the pay is exactly the same.

We glide through the air with "Jennie" the jeep
Held in our laps unable to leap
If she ever breaks loose our widows will weep
And the pay is exactly the same.

We hike and we sweat, we load and we lash
We tie it down well, in case of a crash
We take off and land and climb out like a flash
And the pay is exactly the same.

We glide through the air with the greatest of ease
We do a good job and we try hard to please
The Finance Department we pester and tease
And the pay is exactly the same.

OH, . . . once I was happy, but now I'm Airborne
Riding in gliders all tattered and torn
The pilots are daring, all caution they scorn
BUT . . . the pay is exactly the same.

Several new regiments were added to the workforce and the monsoon season finally came to a close. The road progressed a mile a day. Around the same time, the engineers were placed under the new leadership of Brig. Gen. Lewis A. Pick. As new units arrived—including the other African-American aviation engineer battalions—General Pick dispatched one, and then another, beyond the road head to open road sections and to blaze the way. By the middle of November, thanks to new equipment, additional troops, and General Pick's around-the-clock schedule, the road head connected with an advanced section about 40 miles from Shingbwiyang. By the end of the month, another 20 miles was complete. In addition to roadwork, detachments from the aviation engineer battalions also built a number of landing strips alongside the route so that supplies could be delivered.[246]

On December 27, 1943, five days ahead of schedule, General Pick announced that the 117-mile section of road from Ledo to Shingbwiyang was open to truck traffic. He congratulated the men on opening 54 miles of trace in 57 days. A convoy rolling over the road to Shingbwiyang delivered candy, doughnuts, and 9,600 cans of beer to the troops. Brig. Gen. William E. R. Covell, the head of the U.S. Task Force in China, responded that the Ledo Road would "stand forever as a monument to the unstinting labor, courage, determination and ingenuity of both the living and those who gave their lives in this remarkable accomplishment."[247]

Progress from Shingbwiyang south to Myitkyina was slowed by Japanese resistance and the diversion of engineers to support the campaign in Myitkyina. That section of the road required the erection of bridges across streams and rivers, especially difficult during the 1944 monsoon season. After reaching Myitkyina, engineers were involved in a two-month combat campaign. The Japanese finally capitulated and abandoned the town in early August. All engineers in the fight at Myitkyina received the Presidential Unit Citation.[248]

The Ledo Road was completed to the junction with the Burma Road in autumn 1944. On January 12, 1945, General Pick led the first convoy of 113 vehicles—driven by representatives of all of the engineer units that worked on the road—from Ledo to Kunming, China. Some 65 radio, magazine, and newspaper correspondents accompanied the units. The convoy was welcomed by the Chinese Minister of Foreign Affairs on January 28; the governor of Yunnan Province hosted a banquet in their honor.[249]

After finishing touches, General Pick announced the formal completion of the Ledo Road on May 20, 1945. It was an assignment that he called the toughest job ever given to U.S. Army engineers in wartime. At the suggestion of Chiang Kai-Shek, the road was renamed "The Stilwell Road;" to engineers who built it, the road affectionately was known as "Pick's Pike." With the road finished, eight construction battalions moved into China, transporting their heavy equipment over the famous road they helped build. The 858th and 1891st Engineer Aviation Battalions were among those that made the journey, stopping occasionally to patch the road as they went along.[250]

In China, airfield construction had been underway since 1943. Only a handful of aviation engineers advised Maj. Gen. Claire L. Chennault, commander of the Fourteenth Air Force. Col. Herman Schull, Jr., headed the Engineer Section at Chennault's headquarters at Kunming, China, beginning in August 1943. He was later succeeded by Col. Henry "Hank" Byroade. Construction of B-29 bases at four sites in Szechwan Province, northwest of Chungking, began in late 1943. By April 1944, Colonel Byroade was overseeing maintenance of eight major fighter and bomber fields in eastern China, and construction was underway on eight additional fields. Eventually, 25 fields were built or improved. The Chinese Military Engineering Commission controlled the construction program. U.S. engineers mainly performed engineering staff work. They also assisted in organization, administration, and payment of the 300,000 to 500,000 local workers conscripted by the governor of Szechwan to work on the airfields.[251]

Airfield construction was conducted by hundreds of thousands of Chinese laborers, using whatever methods were available. Chinese men and women carried heavy loads of earth, stone, or other building materials in twin baskets slung from poles across their shoulders. Rollers to compact airfields were drawn by teams of Chinese, often a hundred or more to each roller. Excavation was completed using hand tools. The U.S. principle of installing drainage first to protect the subgrade from the softening effect of standing water was often difficult to enforce. The Chinese engineers, accustomed to installing the drainage system last, clinched the argument with the inscrutable reply, "We've been doing it like this in China for two thousand years."[252]

During summer 1944, aviation engineers had the heartbreaking experience of performing airfield denial against some of the newly-built fields in eastern China. A major Japanese offensive in late May resulted in attacks on the airfields used by Fourteenth Air Force to strike Japanese shipping. As the offensive advanced, Chennault's engineers had the painful duty of destroying the fields before they were overrun. They detonated bombs in the taxiways and runways, while other air force personnel burned buildings. The loss of those airfields created the need for new ones in central and southern China. In October 1944, the Fourteenth Air Force engineer arranged with the Chinese to build two medium bomber bases west and northwest of Kweilin.[253]

After the Ledo Road was open in early 1945, aviation engineers reached China in significant numbers with heavy equipment. Unfortunately, by then the B-29s had moved out of China. In the final months of war, no new large scale engineering projects were undertaken. Meanwhile, the war in the Pacific rapidly was reaching its conclusion.[254]

Iwo Jima and Okinawa

Iwo Jima was seized between the two major invasions of the Philippines and Okinawa. The island was valuable strategically as a staging base for B-29s attacking Japan and as an emergency landing site for crippled aircraft returning from bombing runs. The initial schedule for capturing and expanding airfields on Iwo Jima was predicated on securing the island after a three or four day battle; it took four weeks to clear the island. Heavy spring rains caused significant delays once construction began; engineers faced other problems, such as volcanic steam pockets that had to be avoided when laying out runways and gasoline lines. The volcanic ash on the island was easier to work with than the coral often encountered in the Pacific; however, the ash eroded easily, even when compacted, and asphalt could only be laid on a thoroughly dry ash base. In June, an asphalt area approximately 80,000 square feet in size was ruined by water penetrating into the sub-base, causing significant delay. Construction on Iwo Jima was assigned to the 9th Naval Construction Brigade and the 811th Engineer Aviation Battalion.[255]

Once completed, airfields on Iwo Jima covered nearly four square miles and half the surface of the island. Fighter strips at North and South Fields were paved and augmented by taxiways and hundreds of hardstands. The main B-29 runway was paved and extended 9,800 feet. A second strip was graded to 9,400 feet by V-J Day but was never surfaced. An old east-west runway served as a 6,000-foot fueling strip. During the six months between the landing of the first B-29 on Iwo Jima and the formal surrender, the island was in constant use by long-range bombers. Its function as a recovery base also proved important. By the end of the war, B-29s made an estimated 2,400 emergency landings on its runways.[256]

Construction plans for Okinawa and other islands in the Ryukyus were initially massive in scope, involving 93 aviation engineer battalions and extensive airfield construction to support the anticipated invasion of Japan. If Japan had not surrendered, many of the veteran aviation engineer units from the European theater would have been assigned to the mammoth construction program.

When the attack on Okinawa lagged after the initial April 1, 1945 landings, priority shifted to seizing nearby Ie Shima and its three Japanese airstrips. Ie Shima became known as the "most valuable eleven square miles of land in the western Pacific." By April 30, Japanese airstrips were restored, and by May 12, an all-weather strip was ready. In June, two all-weather strips with crowded parking for over 450 planes were operational.[257]

On Okinawa, engineers found that the old Japanese airfields were surfaced lightly and badly damaged. At Kadena Field, they exerted great effort to haul coral for resurfacing the runways. One airstrip was ready for dry weather use in two days, and by May 1, converted to an all-weather runway despite continuous bombing, strafing, and shelling. By June 22, only 31,400 of 80,000 scheduled construction troops had reached Okinawa. General Arnold interceded with Admiral Chester Nimitz and aviation engineer shipments were accelerated. On July 11, General Kenny wrote to General Arnold that new fields were "appearing like magic and construction is going on faster than I have ever seen it before."[258]

Air Force and Marine flying units, some redeployed from Europe, moved into the Ryukyus as quickly as airfields were ready. Three bombardment groups began flying missions in early July. They concentrated on attacking shipping lanes, and destroying or neutralizing installations in Kyushu and western Honshu. They also provided air protection for naval forces. Some bomb groups used Kadena until Machinato could be captured and repaired. Heavy bombers were based at Yontan, while fighters were crowded onto airfields at Ie Shima. The aviation engineers in the Ryukyus, like the air crews, seemed to come from everywhere—the Philippines, Guadalcanal, Alaska, Guam, and the United States.[259]

The War's End

By July 1945, 33 aviation engineer battalions were assigned to the Army Air Forces Pacific Ocean Areas. They were organized into the 927th Engineer Aviation Regiment on Guam, the 933d Engineer Aviation Regiment on Okinawa, and the 935th Engineer Aviation Regiment on Ie Shima.[260]

The air campaign against Japan steadily increased in intensity during spring and summer 1945. It climaxed with the atomic bomb attacks on Hiroshima and Nagasaki on August 6 and 9. The Allies declared August 15 as V-J Day, and the occupation of Japan began with the landing of U.S. paratroops at Atsugi Airfield on August 30. The official surrender on September 2 came as engineers were still building the garrison in the Ryukyus. On Okinawa, 26 battalions were finishing construction on six airfields, which totaled 25 miles of paved runways and enough taxiways, hardstands, and parking aprons to equal 400 miles of two-lane highway. The long war against Japan was over. Aviation engineers were an integral part of the effort, building airfields to support Army Air Forces operations from the barren reaches of Alaska to the deserts of Australia, and from the remote islands of the Central Pacific to India and China. Hundreds had given their lives to achieve a timeless victory.[261]

The experiences of aviation engineer battalions in the Pacific and CBI theaters were notably different from those of battalions that served in Europe, the Mediterranean, and North Africa. In those theaters, engineers were under the direct control of Army Air Forces commanders and were used almost exclusively on airfield construction. The chain of command in the Pacific resulted in the consolidation of engineers from all services in general support of the combat effort. Aviation engineers worked closely with Navy Seabees to build more than 200 runways from Australia to Okinawa. They were diverted from aviation-related construction to unusual projects such as the Ledo Road, and bridge and road projects in the Philippines and New Guinea. They saw considerably more direct combat than their comrades in Europe. In an immense theater, they performed remarkable engineering feats in the face of almost unspeakable obstacles. Their superhuman effort played a major role in winning the war in the Pacific and set a standard for all future expeditionary engineers to admire and to emulate.

Worldwide during World War II, the number of U.S. aviation engineers peaked at 117,851 personnel in February 1945. This number accounted for approximately five percent of the total Army Air Forces.[262] In all, U.S. aviation engineers serviced, built, or improved 1,435 airfields for the Army Air Forces in 67 foreign countries.[263]

Occupation Forces

The majority of aviation engineers returned to the United States and were mustered out of service. Many remained in theater as part of the Armies of Occupation in Germany and Japan into 1946 and even 1947. Temporary airfields that supported combat operations needed to be dismantled and huge depot facilities had to be maintained to accommodate the vast quantities of war materiel being processed and dispersed. Airdromes that the Army Air Forces retained as the base of permanent operations in Europe and Asia required post engineer organizations to assume responsibility for day-to-day operations and maintenance. At the same time, several aviation engineer battalions remained on board to perform major repairs and accomplish additional construction.

In Europe, Operation Eclipse outlined plans for the occupation of Germany following the defeat of Nazi military forces. The U.S. Occupation Air Forces (OAF) required a balanced combination of bomber, fighter, and transport bases—some existing and some new. Decisions awaited action on the Occupation Zones among the Allies. Tasks facing the aviation engineers included identifying bases and divesting them of camouflage networks, repairing runways and taxiways, extending runways at those bases projected to host heavy bomber units, reclaiming or building housing for troops, restoring rail facilities and roadways, and constructing depot and storage facilities.

The IX Engineer Command remained responsible for construction in Germany following V-E Day, until the command was succeeded by the European Aviation Engineer Command (EAEC) in January 1946. In April 1946, the commander of the EAEC activated three Air Engineer Districts to supervise and to coordinate construction activities: Frankfurt, Nuremberg, and Munich. In November 1946, the Air Engineer Section of the U.S. Air Forces in Europe (USAFE) assumed responsibility for the construction program on European air bases. When the USAFE Air Engineer took over, he reduced the districts to two, the Eastern Air Engineer District at Landsberg Air Base and the Western Air Engineer District at Wiesbaden Air Base. Engineer Aviation Battalions assigned to accomplish major construction in Germany were the 831st, the 850th, and the 862d. They were augmented initially by 500 prisoners of war, 8,500 local civilians, and the 332d General Service Regiment.[264]

Overall, 33 OAF airfields were built or rehabilitated in Germany. Original plans called for nine heavy bomber bases, three light bomber bases, one medium bomber base, four major transport bases, a generous number of fighter bases, and airfields to accommodate liaison and reconnaissance units. Firm planning was difficult as a result of the fluid postwar situation and because basing plans shifted as missions evolved.[265]

Engineers encountered a new set of problems in conducting postwar construction. By directive, they were supposed to employ German civilian labor and materials from German stocks or production to the maximum extent possible. Although these objectives were good in theory, engineers did not know which manufacturing plants would be restored to production in time to meet construction demands. Reparation demands of the Allied powers also hindered the availability of resources.

Cement was a key requirement for construction. Aside from finding plants to manufacture cement, very little rail transport was available in the early months following the war. Materials had to be trucked forward from the Rhine River. By summer 1945, basic rail service was restored to the Nuremberg, Stuttgart, and Munich areas, although local track and sidings still needed to be laid. Engineers developed their own cement production capability to meet the total demand.[266]

Labor was a continuing problem. Although plans called for using German civilian labor to supplement aviation engineer battalions, in summer 1945, no one knew how many qualified German workers were available. By mid-1946 the program hit its stride; that summer, EAEC units performed construction on 50 major projects. Battalion commanders focused first and foremost on finishing runways and taxiways. They then turned their attention to support facilities and troop housing, which was in short supply and had its own impact on operations.[267]

In fall 1946, the rehabilitation of Rhein Main airport to create a major transportation hub had the highest priority. In October, 2,500 men were employed on the project, making it the largest construction project in the U.S. zone of occupation. The other project of great significance was Tempelhof Airport in Berlin. The 852d Engineer Aviation Battalion was given the job of constructing an east-west runway out of pierced steel planking. The PSP was laid over a rubble base topped with concrete. It was completed in September. The 852d was withdrawn by the end of 1945; a force of 1,400 largely German civilians carried out rehabilitation work on the seriously damaged airport buildings and facilities for the next two years.[268]

By the time the Air Force gained recognition as a separate service in September 1947, most major construction in Germany was complete. The work transitioned from a higher percentage of heavy construction to a higher percentage of small-scale repair projects accomplished by the installation squadrons assigned to the respective operational bases.

Meanwhile in Asia, postwar reconstruction began first in the Philippines and followed General MacArthur's re-capture of the islands in spring 1945. Much energy was put into restoring facilities in and around Manila, not only to reverse wartime damage but to prepare a main staging area for the anticipated invasion of Japan. The Engineer reconstruction mission in the Philippines was more robust than in Germany or Japan. As a former U.S. commonwealth, the Philippines also received more assistance than the defeated enemies. As the war in Europe drew to an end, the redeployment of significant engineer resources from Europe to the Pacific was a boon to construction in the Southwest Pacific, but had a negative impact on postwar construction in Germany.[269]

An Engineer Construction Command (ENCOM) was established on March 9, 1945 under the Services of Supply for the Southwest Pacific. The two existing engineer districts on Leyte and Luzon were assigned to ENCOM. The Luzon district peaked at 20,000 engineer troops and a similar number of civilian laborers in July 1945. Engineers in the Philippines, including aviation engineer battalions, simultaneously worked on restoring port facilities destroyed by the Japanese, who left 600 sunken vessels in the Manila harbor. They also assisted with public utilities and roads and repaired or constructed 20 airfields on Luzon and 25 on the rest of the islands. They built extensive new fuel storage facilities and hospitals, installed 500 miles of pipeline, constructed nine million square feet of covered storage, and created a staging area for 350,000 soldiers.[270]

ENCOM transferred from the Philippines to Japan on September 1, 1945. The projects of greatest immediate concern were airfields and troop housing. Engineers found that Japanese airfields were poorly constructed and could not accommodate heavy use by forces. Although many Japanese barracks were available, they suffered from inadequate heating since boilers and radiators had been removed to provide scrap for the Japanese war effort.[271]

Aviation engineers also divided their efforts between Japan and Korea. At the request of theater commanders, the Chief of Engineers established a separate Western Ocean Division with four districts. Manila, Okinawa, Honolulu, and Guam were designated to handle construction outside the occupied areas. As in Europe, by 1947 the major construction program ramped down, and repairs and maintenance became the responsibility of small installation squadrons assigned to Far East Air Forces units on Japanese and Korean bases.[272]

LESSONS LEARNED FROM WORLD WAR II

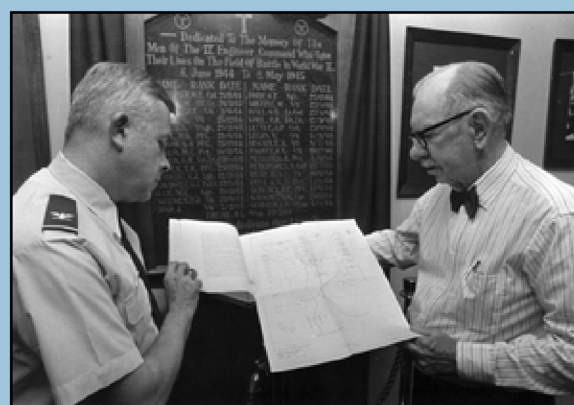
Aviation engineers made a concerted effort to capture all of the lessons learned through hard-won, and sometimes painful, experiences during the war. In late June 1946, nine senior officers with extensive wartime aviation engineer experience were appointed by the Secretary of War (at the request of the Army Air Forces) to a special Board of Officers assigned to compile and analyze those lessons. Their task was forward looking in nature. The ultimate purpose of their report was to recommend the most effective doctrine, organization, and policies to govern future aviation engineer support to Air Force operations. The report board was specifically asked to "make appropriate recommendations as to organization, equipment, employment, and control of Aviation Engineers in support of an autonomous Air Force."[273]

Probably the most direct lesson learned from the war was that centralized control of aviation engineer construction forces was required to ensure the efficient prosecution of major projects. Dispersing

IX Engineer Command Remembered

On May 30, 1946, a bronze plaque commemorating the accomplishments and sacrifices of the IX Engineer Command was dedicated at the headquarters for the European Aviation Engineer Command at Schlangenbad, Germany. The plaque lists the names of 31 aviation engineers who gave their lives in the line of duty while assigned to the command. Among the IX Engineer Command members present at the ceremony was Col. (later Maj. Gen.) Robert H. Curtin. He later served as the Air Engineer for U.S. Air Forces in Europe and completed his career as the Director of Civil Engineering at Headquarters USAF from 1963 to 1968.

The plaque remained in place until 1963, when the building was scheduled to be returned to the German government. Brig. Gen. Oran O. Price, the USAFE Director of Civil Engineering at the time and a former IX Engineer Command member, was preparing to leave Europe to become General Curtin's deputy at Headquarters USAF. He transported the plaque to Wright-Patterson AFB, where it found a new home in the lobby of the School of Civil Engineering at the Air Force Institute of Technology. General Price helped rededicate the plaque on June 6, 1963, the 19th anniversary of D-Day. Twenty-two years later, it was rededicated again on May 16, 1985 to commemorate the 40th anniversary of V-E Day. Once again, General Price attended to bring the legacy of IX Engineer Command to life for attendees. In December 1994, the plaque moved to its current home in Building 643 at AFIT, home of the Civil Engineering and Services School.



Col. Marshall W. Nay, Jr., dean of the School of Civil Engineering in 1985, and Brig. Gen. Oran Price (USAF, ret) examine a map showing the locations of air bases built by the engineers of IX Engineer Command following the Normandy Invasion.

"The centralization of command of all Aviation Engineer units under one Engineer Command, directly responsible to the Air Force Commander was the only method of control which would and did enable the construction, rehabilitation, and maintenance of airfields to be performed in accordance with the overall requirements of the Air Force commander in his area of responsibility."

"Report of a Board of Officers on Aviation Engineers," submitted to the Commanding General, Army Air Forces, July 29, 1946, Tab B, 4.

engineer forces under subordinate commands led to inefficient employment of construction forces and to delays in completing vital operational projects. When engineers were pooled in a theater, in a Services of Supply construction agency, or under Air Service Command, Army Air Forces commanders were dissociated from construction programs being conducted specifically to support their missions. On the other hand, when Theater Air Forces had direct control of aviation engineer units, as they did in the Twelfth and Ninth Air Forces, results were vastly improved. Establishing a separate Engineer Command illustrated the value of having a senior aviation engineer with dedicated staff to advise and assist Army Air Forces commanders. When the Engineer Commands were involved in tactical and logistical planning, the Chief Engineer was able to coordinate engineer activities in support of operations. Chief Engineers could also monitor the supply status of units in the field, and use their influence as members of the Command Staff to secure essential supplies.[274]

Other key lessons learned identified by the Board of Officers are summarized as follows:

- There was a tendency to approve construction projects for the aviation engineers based on what was desired, without considering what was actually possible. Failure to include aviation engineers in initial planning resulted in underestimations of engineering efforts and the equipment support requirements needed to support operations.
- Theaters lacked a clear, published construction policy that spelled out for operational commanders the capabilities, limitations, and responsibilities of aviation engineers, as well as the channels and procedures for submitting construction requests and setting priorities for different types of projects. When policies did exist, they were not effectively enforced by the Army Air Forces theater commanders.
- Reconnaissance and site selection procedures were not well coordinated, and there was insufficient cooperation between ground and air elements. Engineers on the ground were not qualified to look for potential restrictions to flying operations, and pilots were generally not qualified to identify potential engineering difficulties. Reconnaissance parties ideally included a flying officer, an aviation engineer, and a weather officer.
- Aviation engineers learned that they needed their own organic equipment maintenance capability. Significant downtime for maintenance occurred due to rugged terrain, 24-hour operations, and vehicle abuse by inadequately trained operators. Equipment maintenance units were largely assigned to organizations not involved in supporting Army Air Forces operations. Other major problems with equipment included coordinating deployments of men and equipment so they arrived at the same time and avoiding theft or diversion of equipment and supplies en route or at construction sites.
- Training for aviation engineers was deficient in a number of areas and was not timely. Subject areas where training was lacking included: operation and care of equipment, planning for around-the-clock operations, technical practices such as preparation and drainage of subgrades and surfaces, erection of prefabricated facilities, site selection procedures, and bomb and mine removal.
- The premise that there would always be enough local labor to supplement small military construction forces proved to be false, particularly in remote areas. Project planning should stipulate sufficient numbers of skilled, trained engineers to do the job.
- Extensive experience in heavy construction was obtained only from actual work. More effort was needed to recruit men from industry who were already proficient

and to ensure that enlistees with experience were channeled to the engineers. Heavy operations should be accomplished only by experienced, mature commissioned and enlisted personnel.

- Acquisition, storage, and issue of engineer supplies needed to be controlled to protect assets and expedite transportation, based on the Theater Air Commander's priorities. The Services of Supply controlled the distribution of common items such as lumber, asphalt, and corrugated sheeting. The Air Force Service Command controlled special construction items peculiar to the Army Air Forces, such as steel planking and portable hangars. Even when materials were successfully ordered and received in theater, there was generally not enough rail space authorized for the Air Forces to transport heavy supplies to aviation engineer units in the field. The units themselves did not have sufficient organic transport to haul supplies from the depots to their sites.
- Building revetments required extensive effort and then provided reasonable protection only against general-purpose bombs. The decision to construct revetments should be carefully weighed against the advantages afforded by construction of better dispersal facilities or even additional airfields.
- Aviation engineers needed a comprehensive plan for gathering information on new developments in the engineering field, as well as regular channels for disseminating information on new developments and lessons learned through experience.
- Engineers suffered from a number of health problems due to poor living conditions, long hours or rigorous work (10-12 hours a day, 7 days a week, for 3-4 years), harsh environments and climates, lack of food and clean water, and diseases such as dysentery and malaria. Those areas needed to be addressed, and engineers should be allocated extra rations to help them sustain heavy construction for extended periods.
- Engineer units should be maintained intact and not be required to surrender skilled personnel to perform other duties, such as fill vacant infantry positions. It was also inefficient to divert troops specially trained for airfield construction to perform road, bridge, and other miscellaneous construction projects. Ensuring control of aviation engineer units by the Army Air Forces was the best way to counter that problem.[275]

The list of specific recommendations submitted to the Commanding General of the Army Air Forces contributed greatly to discussions already underway at the highest levels. At the heart of those recommendations was the assumption that any engineer force needed to be *immediately available* for participation in operations. Waiting for engineer troops to be organized and properly trained prior to deployment was not an option given the fast-paced nature of air operations. That message was clearly reinforced by the Army Air Forces major commands when they coordinated and commented on the draft recommendations. Projecting U.S. air power to the far reaches of the globe called for prompt, effective engineer support. Although it would be years before a dedicated emergency engineer force, the Prime Base Engineer Emergency Force (Prime BEEF) and Air Force Civil Engineer Rapid Engineer Deployable Heavy Operational Repair Squadron, Engineer (RED HORSE), were created using many of the lessons learned during World War II.[276]

Col. Rudolph E. "Jerry" Smyser, Jr.

One of the key members of the Board of Officers convened to study Aviation Engineer lessons learned was Col. Rudolph "Jerry" Smyser. He had recently returned to the United States from his post as commanding officer of the European Aviation Engineer Command (EAEC). The son of a career Army officer and a 1928 graduate of the U.S. Military Academy, Colonel Smyser had been involved in organizing and defining the role of Aviation Engineers from the very beginning. As executive officer to Col. Donald Davison at General Headquarters Air Force and later Assistant Engineer for Air Force Combat Command, he helped define the structure and proper equipping of aviation engineer battalions in preparation for their wartime support role. He served as chief of the Engineer Section at Eighth Air Force for two years, where he worked on Operation Overlord plans and helped establish IX Engineer Command. He then served as the A-4 for Ninth Air Force, before succeeding Brig. Gen. James Newman as commanding officer of IX Engineer Command. He became the first EAEC commander in January 1946. With nearly five years of service with the aviation engineers in Europe, he brought a wealth of corporate memory to the Board of Officers' deliberations.

The major command engineers were also forward-looking in their analysis when they recommended that any future planning for engineer support should be "polar-minded" to support strategic defense of the nation. They also recommended that every consideration be given to establishing an Aviation Engineer organization in the Air Reserve capable of meeting the requirements of sudden emergencies.[277]

SETTING SIGHTS ON AN INDEPENDENT AIR FORCE

The dream of Airmen to see an Air Force established as an autonomous service, co-equal with the Army and the Navy, was at last within sight at the end of World War II. Army Air Forces leaders felt their wartime record clearly demonstrated, once and for all, the effectiveness of air power and had earned them an equal position in the national defense establishment. Support for the change came from several important quarters. Army Chief of Staff Gen. George Marshall had worked closely with General Arnold during the war and backed the concept. Gen. Dwight Eisenhower, who succeeded General Marshall as Chief of Staff in November 1945, was convinced of the strategic value of air power from his wartime experience and also supported the drive for independence from the Army. He was quick to remind people that the successful invasion of Europe would have been impossible without air superiority. Moreover, President Truman, who clearly articulated that he wanted the services unified under a single department of national defense, felt that the air arm should have parity.[278]

As early as 1943, General Arnold began setting the stage by appointing formal groups to engage in postwar planning. They primarily looked at the force levels required in the postwar era and how Army Air Forces headquarters and the major commands should be organized. In August 1945, the Army Air Forces adopted a "70-Group Objective," which became the foundation for the postwar Air Force. In March 1946, Army Air Forces Chief of Staff Gen. Carl "Tooey" Spaatz instituted a major reorganization that ultimately resulted in functional changes for many installations. The reorganization was based on extensive planning and was done in such a way that when the Army Air Forces became an independent service, it would not have to immediately revamp its major commands once again.[279]

With General Eisenhower's concurrence, three major combatant commands were established:

Strategic Air Command, Tactical Air Command, and Air Defense Command. Eleven of the 16 wartime numbered air forces were assigned to these commands. Five other major commands and three theater commands rounded out the force. At Headquarters Army Air Forces, General Spaatz organized his staff into a structure analogous to the War Department General Staff system, including five assistant chiefs of air staff. The Director of Air Installations, Brig. Gen. Robert Kauch, reported to the AC/AS-4 (Materiel), formerly known as the AC/AS for Materiel, Maintenance, and Distribution. Separate from the Director of Air Installations, the Air Engineer also reported to the AC/AS-4. The Air Engineer was concerned with aviation engineer battalions and troop construction rather than post engineer operations and responsibilities.[280]

Between mid-1947 and September of that year, Strategic Air Command began its dramatic era of growth. It expanded from 6 air bases to 11 in the United States, with an ultimate goal of 25 bases to house the strategic deterrent force. Engineers at those bases and at others across the country struggled to maintain facilities and housing, most of which had been constructed as temporary wartime structures. Postwar dollars were scarce, and manning was headed to an all-time low. Regardless of whether they belonged to the Army or Air Force, post engineers who elected to stay in the service after the war knew that they had a tough job ahead of them.[281]

As the march toward independence progressed, the Army Air Forces looked forward to new missions, a new basing structure and new organizations—in general, new horizons. The future looked exciting as an independent Air Force prepared to take control of its own destiny. The Army engineers who had been serving the air arm since 1907 did not know exactly what shape their future would take, but they knew for certain that engineers would play a big role in determining the success of the new Air Force's endeavors.

CHAPTER 2

ESTABLISHING INDEPENDENCE
1947-1959

INTRODUCTION

On July 26, 1947, President Harry S. Truman signed the National Security Act into law. This act created the U.S. Air Force as an independent branch of the U.S. armed forces and established the office of the Secretary of National Defense. The authorization of the separate Air Force marked a major, and long anticipated, achievement.

The period from 1947 to 1959 was a time of unprecedented challenges for Air Force engineers. Engineers assigned to the newly formed Air Force began careers as air installation personnel, then installations engineers; by 1959, the function formally was renamed civil engineering. Air Force installations engineers welcomed the opportunity to forge a distinct identity within the new branch of the U.S. Armed Services. While mindful of their Army heritage, engineers took pride in defining the role and mission of Air Force civil engineering and in crafting the internal regulations and procedures to support new functions.

The Cold War dramatically impacted the engineering community. The hardline stance of the U.S.S.R. and U.S. foreign policy response led the United States to maintain a sizeable overseas military presence and to reaffirm commitments to the defense of Europe and Asia. Basing decisions during the Cold War relied heavily on civil engineer support. Air Force installations personnel managed an increasing number of permanent bases in the continental United States (CONUS) and in Europe, North Africa, the Middle East, Iceland, Greenland, Korea, Japan, and Taiwan. From 1950 to 1953, Air Force installations engineers and Army combat engineers assigned to the Air Force also built and maintained the bases needed to support air power during the Korean Conflict.

Civil engineers joined aeronautical engineers in supporting a wave of new technologies adopted by the Air Force in the 1950s. The advent of nuclear weapons and missile technology was accompanied by a new perspective on national defense. Civil engineers became involved closely in the development of radar early warning systems across the Arctic and oversaw planning and programming for complex facilities to deploy successive generations of missile systems. Engineers were indispensable in the development of new weapon systems; in many cases, support facilities were integral to the operation of these systems.

At the same time, civil engineers improved and maintained bases for the Air Force. Air Force size peaked in 1956 and included 183 wings (143 combat wings) located on 162 major operational installations. Air Force civil engineers met myriad challenges related to increasingly more powerful jet aircraft – fighters, nuclear-capable bombers, and transports – and growing Air Force communities. They redefined the world of fire-crash rescue. They implemented the Wherry and Capehart housing programs to provide modern, affordable housing for Air Force personnel and their families. From 1954 to 1958, they planned and oversaw construction of the U.S. Air Force Academy.[1]

Air Force civil engineers were keenly aware of their professional role in the growth and development of the postwar military. Successful Air Force careers were assured through commitment, educational advancement, and professional development. Leaders of the Air Force civil engineering community strove to implement a wide range of engineering programs to advance the growth and maturation of the new Air Force.

THE NEW AIR FORCE

Air Staff Organization 1945-1947

The civil engineer organization at Headquarters U.S. Army Air Forces from 1945-1947 was similar in structure to that which existed at the end of World War II. Two separate departments were in place; both reported to the Assistant Chief of Air Staff for Materiel (AC/AS-4). The Air Engineer, Brig. Gen. Samuel D. Sturgis, Jr., was responsible for aviation engineer units and troop construction in the overseas theaters of war. After September 1944, a new organization was established to oversee the repair and maintenance of real property and to operate utilities at CONUS Army Air Forces installations. The Director of Air Installations, Brig. Gen. Robert Kauch, was responsible for matters pertaining to construction, real estate, repairs, utilities, fire protection, and other post engineer responsibilities.[2]

General Sturgis argued vehemently in favor of a comprehensive engineer force, not only to build and to maintain Air Force bases, but also to perform all functions previously assigned to aviation engineer units. He advanced his position in correspondence with the Air Board and with the secretary-general of the board, Maj. Gen. Hugh Knerr. In May 1947, General Sturgis submitted an Air Engineer Plan that called for the creation of an Air Engineer Service with clearly defined functions.[3]

The Army Air Forces argued for maintaining an organic construction capability within its engineer organization based upon several valid assumptions. The first assumption was that the next war would begin with a sudden attack. Oceans and distance no longer safeguarded the United States. Mobilized forces within striking distance of potential enemies were required to be ready to project force at a moment's notice. A large engineer force was needed to support these requirements. The pre-World War II concept of maintaining an engineer component at five percent of the total force was too low to meet projected Air Force requirements. Most importantly, wartime experience had demonstrated the importance of centralized control by the Air Force over the engineers who built and maintained air bases, so that those engineers functioned as a strong organic part of the Air Force fighting force.[4]

General Sturgis's Air Engineer Plan addressed both the requirements for engineer forces on the home front and in expeditionary environments. He proposed creation of an Air Engineer Service, headed by the Air Engineer in Washington, and comprising elements at all levels of the Air Force command structure. The Air Engineer Service would be responsible for constructing all bases and facilities in active theaters of war and in occupied areas in time of peace. The engineer aviation battalion would form the basic unit. The Air Engineer Service also would be responsible for training and coordinating all manning, activation, and movement of Air Engineer units. For construction in CONUS, General Sturgis's plan advanced the establishment of a new Engineer Force at the National Defense level to execute construction for all three U.S. Armed Services. Under this scenario, new construction for the Air Force would continue to be undertaken through the U.S. Army Corps of Engineers until the new Engineer Service was created.[5]

General Sturgis proposed a manpower structure that called for 33 Engineer Aviation Battalions with subordinate aviation engineer maintenance companies, depot companies, firefighting detachments, and several other supporting companies. He called for a parallel structure in the Guard and Reserve. The total manpower requirement was149,434 troops - 43,674 in the active Air Force and the balance in the Guard and Reserve. His estimates for the active force were close to the figure projected by other leaders planning for the independent Air Force. The proposed 70-group structure for the new Air Force called for a 400,000-strong active force, including 46,958 slots designated for the Engineer Service.[6]

Unfortunately, the Air Engineer Service proposed by Sturgis had little chance of being realized. The Army Air Forces, like the other U.S. Armed Services, based postwar planning on the pragmatic military experience of World War II. The political reality of postwar America was influenced by the sentiments of a country tired of war and national budgets that had been stretched to finance the recent world conflict. Demobilization, economy, and reduced duplication among the Services were the watchwords of the day.

Establishment of an Independent Air Force, 1947-1951

The creation of the independent Air Force was made possible through three legislative acts: the National Security Act of 1947, the Army and Air Force Authorization Act of 1949 passed in July 1950, and the Air Force Organization Act of 1951. These laws addressed the structure of defense forces, the organizational framework of the branches of the military, and the reallocation of aviation assets and personnel.

The National Security Act of 1947 (Public Law 253), signed by President Harry S. Truman on July 26, 1947, provided "a comprehensive program for the future security of the United States" and established "integrated policies and procedures for the departments."[7] The Act established a National Military Establishment with three departments: the Department of the Army, the Department of the Navy, and the Department of the Air Force. Each department had its own civilian secretary. The first Secretary of the Air Force was W. Stuart Symington, who previously served as the Assistant Secretary of War for Air. On September 18, 1947, Symington was sworn into office and the Air Force came into being.[8]

However, the National Security Act did not assign functions to the separate Air Force that were equivalent to those assigned to the Army and the Navy. Initially, the Secretary of the Air Force assumed only those functions that had been assigned to, or had been under the control of, the Commanding General of the Army Air Forces. The transfer of functions and personnel was completed through a series of Transfer Orders, which were Army-Air Force agreements submitted to the Secretary of Defense for approval. Transfer orders occurred between September 1947 and July 1949.[9]

Civil engineering functions assigned to Air Force were detailed under Section V of the initial implementation agreement dated September 15, 1947. The Air Force, as expected, was granted authority to operate and to maintain its own airfields. This function had been under the control of the Army Air Forces pursuant to War Department Circular 388 dated September 27, 1944. The Air Force gained responsibility to "administer, direct, and supervise repairs and utilities activities at its own installations." Technical standards for repair and operations of utilities were to be developed by each department acting jointly, if feasible. The Air Force was required to formulate requirements for real estate and construction, to provide budget estimates, and to justify those estimates to the U.S. Congress.[10]

The U.S. Army Corps of Engineers was designated as the construction contracting agent for permanent Air Force construction overseas and CONUS and for all contingency situations. This role was formalized in Transfer Order 18 dated July 7, 1948, and Air Force Regulation 88-3 dated July 31, 1950.[11] The Air Force role in facilities construction was limited to programming funds; to preparing specifications, site layouts and architectural designs; and, to reviewing and approving contracts prior to award. The transfer order specified that if Air Force requirements were not met, the Air Force had the option to undertake the job internally or to contract for the work. Selected functions were retained by the Army and gradually transferred to the Air Force over the next several years. For example, although the Air Force had lobbied for responsibility for real estate affairs, the agreement stipulated that the Army initially would continue to act as agent for the Air Force in the acquisition and disposal of real property.[12]

The division of troop construction responsibilities between the Air Force and the Army during peace and wartime also were addressed. The agreement provided that service units organic to Air Force wings automatically became Air Force units, while units that performed services common to both the Air Force and the Army, such as engineer aviation battalions, remained Army units attached to the Air Force. Simply stated, the Army retained the responsibility for troop construction forces for the Air Force until the Air Force and the Army hammered out an agreement to the contrary.[13]

An agreement specific to troop construction was not forthcoming for several reasons. As previously noted, the American public and U.S. Congress supported reductions in military forces and the defense budget. Army construction battalions appeared capable of meeting the peacetime needs of both the

Army and the Air Force. This contention was reinforced by the position advanced by the U.S. Army Corps of Engineers, which held that its construction troops were established, well-trained, and accessible worldwide wherever the Air Force might need them. On the Air Force side, the engineering force was not yet well established. Almost all Air Force engineers had transferred from the Army and the Air Force did not possess the personnel to oversee its own construction program or to manage construction troops. The Air Force faced the immediate challenge of building an organizational structure and recruiting engineers to staff all echelons. Air installation officers (AIO) and personnel for installations squadrons at Air Force bases particularly were needed. Recruitment was challenging due to the keen competition for civil engineers among the military and private sectors in the postwar years.[14]

Although the National Security Act of 1947 established the U.S. Air Force, the legislation provided no statutory authority for Air Force operations, which later was established under the Army and Air Force Authorization Act of 1949, and became law in July 1950. This Act addressed the shortcomings in the National Security Act. Title II of the Act defined the Air Force as comprising the regular Air Force, the Air National Guard (ANG) while in the service of the United States, and the Air Force Reserve. The Act set the authorized manpower for the active-duty Air Force at 502,000 personnel and 24,000 serviceable aircraft organized into 70 groups.[15] Research and development activities were identified as legitimate Air Force activities in Section 205 of Title II. This law also renamed the National Military Establishment as the Department of Defense (DoD).[16]

The Air Force continued to fight for its own civil engineer force. In late 1950, the Director of Installations prepared a detailed rebuttal to the "Vinson Proposal" contained in the draft Air Force Organization Act of 1950. One proposal in this draft legislation was the transfer of the Air Force engineering function to the Department of the Army.[17] The legislation enacted, the Air Force Organization Act of 1951, provided the statutory framework for the internal organization of the Air Force. The Act codified organizational and management policies through administrative action and established the three major Air Force commands: Air Defense Command (ADC), Strategic Air Command (SAC), and Tactical Air Command (TAC). The legislation also codified the internal organization of the Air Force. The Air Staff was established and comprised the Chief of Staff and the Vice Chief of Staff. The Chief of Staff was given command over the major commands. The Air Force Organization Act of 1951 completed the creation of the Air Force as a separate and distinct branch of the U.S. military.[18]

Directorate of Installations at Air Force Headquarters

The importance of installations engineers in the new postwar Air Force was acknowledged by Secretary Symington:

> As air power grows in importance and complexity, it becomes increasingly dependent upon the facilities and services provided by the military engineer…The elements of Air power are constantly changing. The techniques and equipment of World War II are already obsolete. Our new bombers are bigger; our new fighters are faster. In the air world of tomorrow, we must work with such things as atomic weapons, guided missiles, supersonic jet speeds, jet and rocket propulsive devices, and ever-longer ranges. These, in turn, will require air bases and testing facilities on a much greater scale than ever. With each passing day it becomes more apparent that the nature of our air world of tomorrow depends to a large degree on the skill, energy, and resourcefulness of the military engineer. Air power can never be greater than the construction power that backs it up.[19]

The October 1947 organization of Air Force Headquarters integrated engineering duties into the overall organizational structure. Air Force Headquarters comprised three deputy chiefs of staff administering personnel, operations, and materiel. Engineering functions were placed in the Directorate of Air

Installations within the office of the Deputy Chief of Staff for Materiel. By March 1948, the directorate was named simply Directorate of Installations. This directorate corresponded to the U.S. Army Corps of Engineers and the Navy Bureau of Yards and Docks. The Directorate of Installations supervised and planned building acquisition, construction, utilization, preservation, repair, and disposal, and provided and maintained utilities. The Air Force planned and oversaw construction through its Air Force Liaison Offices, renamed Installations Representative Offices in 1951, while the U.S. Army Corps of Engineers acted as the Air Force's agent for contract construction and for the acquisition and disposal of buildings and improvements.[20] Although the U.S. Army Corps of Engineers oversaw Air Force design and construction projects, the Air Force identified the need to establish its own cadre of expert engineers to ensure that engineering specifications were appropriate for bases and support facilities. This "in-house" engineering expertise was particularly important due to the increasing complexity of sophisticated jet aircraft, new weapons, and guided missiles.

The Director of Installations was the staff officer with authority to supervise, approve, and disapprove engineering projects and functions. The directorate was organized into three divisions and two offices.

- Engineering Division oversaw installation planning, construction, repair, and preservation;
- Facilities Division handled acquisition, use, evaluation, and disposal of buildings and improvements;
- Operations Division oversaw strategic war plans, units, personnel, and equipment related to the Directorate.
- Cost and Budget Office
- Policy Office.[21]

On March 19, 1950, the Operations Division was designated the Troops Division and was divided into three branches: Mobilization Planning, Operations and Training, and Organization and Equipment. This division was responsible for the formulation and establishment of policies and procedures, and staff supervision over all matters pertaining to the utilization and equipping of engineer aviation units.[22]

Engineering functions were organized by command below the Air Staff. Each major command had an organization similar to the Air Staff. Air Installation officers served in the command level headquarters and had control over technical and administrative matters related to engineering on the bases under their major command. At the installation level, the AIO served on the staff of the Wing Commander. The AIO oversaw construction requirements, repairs, maintenance of base facilities, as well as utilities, services, and fire protection/crash rescue services. The day to day work at the bases was performed by the air installations squadron. The squadron staff usually comprised four officers, supervising 80 to 100 enlisted and 100 to 200 civilian personnel.[23]

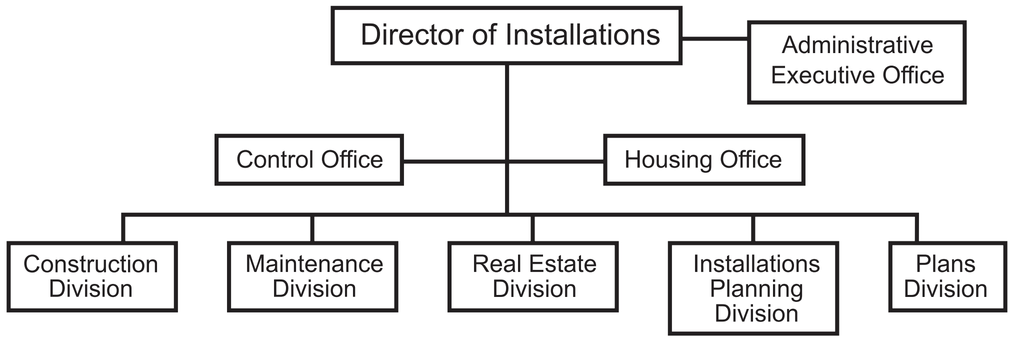
The Air Force actively recruited personnel to fill engineering positions. By October 1948, 53 officers had transferred from U.S. Army Corps of Engineers to the Air Force. These included 14 colonels, 23 lieutenant colonels, 12 majors, and 4 captains. Approximately 100 Engineer Reserve officers also transferred from the Army to the Air Force. Air Force engineer staffing was further augmented through temporary duty assignments of 170 regular and 900 reserve officers from the U.S. Army Corps of Engineers. Three hundred fifty vacancies for AIOs remained.[24] "Giving up the castles," the symbol of the U.S. Army Corps of Engineers, was a major career decision. Officers transferred to maintain or improve their permanent rank. One officer, then-Col. William E. Leonhard, learned of his transfer to the Air Force when his commanding officer bought him a blue suit.[25] The decision to transfer from the U.S. Army Corps of Engineers was made often with regret, but with excitement about new opportunities offered in the Air Force.[26] Personnel transfers from the Army to the Air Force were completed in 1949. In FY50, Air Force civil engineering manpower numbered 25,572, comprising 5,050 officers and 20,522 enlisted personnel.[27]

Brig. Gen Robert Kauch

The directors of Installations during this time period were seasoned officers who had served during World War II in either the Army Air Forces or with the U.S. Army Corps of Engineers. Brig. Gen. Robert Kauch became the first director in 1944 and oversaw the transition from the Army Air Forces to the independent Air Force. The air installations squadrons were organized under his leadership. Between June 1948 and December 1952, four officers rotated through the director position: Maj. Gen. Colby M. Myers, Maj. Gen. Grandison Gardiner, Maj. Gen. James B. Newman, and Lt. Gen. Patrick W. Timberlake. Generals Myers, Newman, and Timberlake were graduates of the U.S. Military Academy at West Point. Generals Myers and Newman held university degrees in civil engineering.[28] General Newman, who had retired in 1946 after having commanded the Ninth Engineer Command in Europe during World War II, returned to active duty to serve as Director of Installations between March 1949 and May 1950. He went on to become the president of the Society of American Military Engineers (SAME). In 1956, General Newman instituted the first annual award to recognize the most outstanding Air Force installations engineer or civilian contribution to military engineering through achievement in design, construction, administration, research or development connected with military engineering.[29] The award was presented by SAME and named the Newman Medal. The first Newman medal was awarded in September 1956 to Mr. William T. Smith, Chief of Refrigeration and Air Conditioning Section, Maintenance Division, Assistant Chief of Staff, Installations.[30]

During its early years, the Directorate of Installations continued to expand. In July 1949, the Housing Office was established to oversee the Wherry family housing program. In March 1950, the Air Staff structure was reorganized into five divisions: Real Estate (new), Troops (formerly Operations), Construction (formerly Engineering), Maintenance (branch elevated to division), and Installations Planning (new) (Figure 2.1). The Control Office assumed the functions of the former cost and budget and policy offices. The Directorate of the Installations was the largest organization at Air Force HQ at the time; personnel totaled 242 and comprised 60 officers, 4 Airmen, and 178 civilians. The mission of the directorate was planning, acquisition, development, utilization, preservation, repair, construction, and disposal of property, as well as providing maintenance and utilities services. The Directorate

Figure 2.1 Director of Installations Organization, 1952



Source: Air Installations, Vol 1, Continental Air Command Manual 50-10, January 1952, 5.

of Installations also was responsible for Air Force family housing provided by private enterprise or by other governmental agencies. On April 3, 1951, the Troops Division was discontinued and its components were folded into the Plans Division and the Aviation Engineer Office.[31] By May 1951, the number of personnel in the Directorate of Installations increased to 327 to direct the expanding multi-billion dollar Air Force construction program.[32]

The Directorate of Installations was relocated within the Air Staff administrative structure on January 1, 1952. The directorate was transferred from the Deputy Chief of Staff, Materiel to the Deputy Chief of Staff, Operations to reflect the close ties between operational readiness and base development.[33] This move facilitated collaboration between the Directorate of Plans and the Directorate of Operations in developing facility requirements for an expanding number of installations.

In June 1952, Maj. Gen. Lee Bird Washbourne became Director of Installations and served in the position until July 1957. General Washbourne was born in the Cherokee Nation, Indian Territory (now Oklahoma). General Washbourne graduated from the U.S. Military Academy, West Point, in 1927 and served in the U.S. Army Corps of Engineers. He earned a civil engineering degree from the University of California at Berkeley and completed the Engineer School at Fort Belvoir, Virginia, in 1930. He attended the Air Corps Primary Flying School at Brooks AFB, Texas, in 1931. In 1940, General Washbourne served with the 20th Engineers (Aviation) at MacDill Field, Florida. In 1941, he assumed command of the 805th Engineering Battalion and was stationed in Panama as engineer staff officer with the Sixth Air Force. By the end of 1944, General Washbourne was serving in the Pacific Theater, where he commanded the 933d Engineering Aviation Regiment. General Washbourne was stationed in Japan at the end of World War II. He transferred to the Air Force in April 1948 and became the AIO for the Strategic Air Command headquartered at Andrews Air Force Base, Maryland. When the SAC headquarters moved to Offutt AFB, Nebraska, General Washbourne moved with the command headquarters and served as Director of Installations for SAC between June 1948 and June 1952.[34]

Changes to the organizational structure of the Directorate of Installations continued under the direction of General Washbourne. In mid-1952, the dual deputy director structure was adopted. The Office of the Deputy Director for Engineering and Construction was established July 31, 1952. Col. (later Maj. Gen.) Robert H. Curtin was appointed deputy director and Lt. Col. C. A. "Bud" Eckert was named assistant. The new deputy director coordinated the efforts of the Construction Division, the Architectural and Engineering Division, and the Real Estate Division. The Architectural and Engineering Division was established in August 1952 to execute effective architectural, engineering, and research and development functions. The Office of the Deputy Director for Planning and Programming was established July 21, 1952. Col. J. F. Rodenhauser served as deputy director and oversaw the Planning and Programming, and Maintenance Divisions. The Public Works Program, renamed Military Construction Program (MCP) in February 1955, and supplemental appropriations programs were prepared under this deputy director.[35]

Maj. Gen. Lee B. Washbourne

In late 1953 and early 1954, a comprehensive study was completed on the relationship of the Directorate of Installations to the command and staff elements at all echelons. The purpose of the study was to determine the most efficient and effective organizational position for the Directorate of Installations within Headquarters, Air Force. The position of the Directorate of Installations as a subordinate organization within a deputy chief of staff did not allow the directorate to have authority commensurate with its delegated responsibility. General Order No. 9 issued on March 16, 1954 elevated the directorate within the Air Staff structure and established the Office of the Assistant Chief of Staff, Installations with three directorates: Construction (divisions: Air Force Installations Representative (AFIR) Office, Engineering, Construction); Real Property (divisions: Real Estate, Plans and Programs), and; Facilities Support. The Directorate of Construction was responsible for "engineering, design, and construction of Air Force real property facilities and the development and preparation of engineering manuals, criteria, plans, and specifications." The Directorate of Real Property was responsible for the "planning, programming, and acquisition of real property." The Directorate of Facilities Support was responsible for the "management and preservation of Air Force real property facilities." The Air Force Academy Construction Agency also was part of the office. In the Office of the Secretary of the Air Force, a Special Assistant for Installations was established, as well as an Office of Properties and Installations in the Office of the Secretary of Defense. By June 1954, the number of personnel authorized for the Assistant Chief of Staff, Installations increased from 455 to 531.[36]

When Maj. Gen. Augustus M. "Gus" Minton succeeded General Washbourne in July 1957, the Directorate of Installations again was restructured.[37] On July 1, 1957, the directorate was realigned back under the Deputy Chief of Staff, Operations.[38] The director was supported by the Deputy Director of Installations, Brig. Gen. William E. Rentz, and deputy directors who oversaw four divisions: Real Property, Construction, Facilities Support, and Air Force Academy Construction. The Air Force Academy Construction Agency was located in Colorado Springs, Colorado. Air Force Installations Representatives in nine offices operated as extensions of the director's office to oversee and coordinate Air Force construction projects.[39] The authorized personnel strength of 629 for the Directorate of Installations

Maj. Gen. Augustus M. (Gus) Minton

was reached in June 1957.[40] Worldwide, Installations Engineering personnel numbered 97,800 and included 1,800 officers, 37,000 Airmen, 36,000 U.S. civilians, and 23,000 foreign nationals.[41]

Programming

The early days in the Air Force were exciting and challenging. New systems and procedures were developed for nearly every task, but the parameters for performance constantly were changing. In 1947, the Air Force inherited approximately $6 billion in real property from the Army. The initial operating budget for the Air Force was $2 billion.[42] The few permanent bases in the Air Force inventory were constructed for the Army Air Corps during the 1930s. Most bases inherited by the Air Force were established during World War II and built with temporary structures. Complicating matters further was the dynamic mission, which affected the size and role of the new Air Force. New or updated facilities were needed on all installations and new classes of installations were necessary to support the missions assigned to the Air Force.

Initially, the newly independent Air Force was authorized to implement a program encompassing 48 combat wings. In September 1950, the Joint Chiefs of Staff approved a 95-wing program. President Truman endorsed a 143 combat wing program at the end of 1951. Each program was accompanied by vastly different requirements for fighter, bomber, transport, and training forces and for bases to support those forces.[43]

Within this dynamic environment, programming of funds and contracting for new construction were continuous challenges. During 1950, the Air Force prepared its first separate budget for presentation before the U.S. Congress. The FY52 budget included funding requests for new construction and operations and maintenance activities.[44] Capt. (later Brig. Gen.) William T. Meredith was instrumental in programming in those early years as the Officer in Charge of Master Planning at HQ Military Air Transport Service (MATS) at Andrews AFB, Maryland. His job was to assemble the construction program to expand operations at 27 Military Air Transport Service (MATS) bases worldwide. He recalled, “Of course, no one had experience with programming, because after the war (World War II) all the budgets were shut down and they weren’t authorizing anything.” Captain Meredith quickly learned about wind roses and the lengths of runways required by specific aircraft. As he reflected,

> We applied all the different criteria we knew, with specific types of aircraft, maintenance facilities, support facilities, and we made up a program list. I guess it took it about month. Then we overlaid it on all those MATS bases worldwide. We developed our first go at a program based on those criteria. I went back in to my boss and gave him a quick rundown on it. He looked at it and said, “It looks good to me. Take it to the Pentagon.”[45]

At the Pentagon, Captain Meredith explained the MATS construction program to the head of Programming, Mr. John R. “Jack” Gibbens. Gibbens had worked in the Installations Directorate since 1946 after serving in World War II with the U.S. Army Corps of Engineers. During the 1950s and early 1960s, Gibbens oversaw the Air Force construction program and would later become the Associate Director.[46] MATS was the first major command to develop a program and the directorate of installations was interested in how the construction program was crafted and its interface with base master planning. After the Pentagon meeting, Captain Meredith was directed to submit the MATS programming package to the U.S. Congress. Gibbens called the House Armed Services Committee and sent Captain Meredith to the Capitol Building. Captain Meredith conferred with two congressional staff members followed by a Congressman. As he recalled,

> I said, “What do I have to do to get Armed Services approval?” He said, “You just got it.” Ended up we didn’t talk about the program, other than I told him what was in there and what it would do and why we needed it. He said, “We’ve got to start. We’ve got a 48-wing buildup. We’ve got to start on the existing bases and then expand those bases.”[47]

Captain Meredith met with the same positive reception at the House Appropriations Committee and in the U.S. Senate. The entire $10 million MATS program was approved. Other major commands soon presented their construction programs to the Pentagon for review and approval.[48]

Between 1950 and 1954, the Directorate of Installations sought to establish an orderly internal programming process to develop integrated packages to support Air Force requests for funding under “acquisition and construction of real property.” The period from 1950 through the summer of 1953 also was a time of escalated expansion precipitated by the Korean Conflict, the increased number of authorized combat wings, continuous changes in base missions, and the urgent construction requirements for the major commands. While the numbers of aircraft and personnel increased rapidly between 1950 and 1953, the preparation of bases lagged.[49]

The Air Force construction program was defined by the military missions established at the highest level of the military hierarchy. The resulting policy directives and instructions then informed decisions on facilities requirements at each base for inclusion in the military construction program. The Air Force engineers, from the Air Staff through the installation-level, identified the physical facilities necessary to meet the Air Force missions. Until the FY53 budget, funding requests for the Air Force construction programs were presented as line items for specific projects tied to specific locations and air bases. New programs, such as the communications systems, were initiated from planning through programming and construction, while air base facilities required continuous upgrades to meet the advancing technologies and operational requirements for sophisticated aircraft and to support the increasing numbers of Air Force personnel. The construction program was balanced against competing funding priorities for facility requirements.[50]

The process for developing the annual military construction program incorporated multiple levels of review. The Directorate of Installations issued design directives to guide base development of projects and budget estimates. Major commands prepared requests for facilities based on the needs identified by the air bases under their command. On the base level, construction projects were proposed and submitted for review by the base Installations Planning Board. The board reviewed each project proposal for compliance with the base master plan and the capacity of the existing inventory of base facilities. Each major command compiled base-level program requests, which then were reviewed by the major command review panel. The resulting program was hand delivered to the Directorate of Installations.[51]

The Directorate of Installations received all proposed programs from the major commands. All submittals were reviewed by working groups to ensure that the proposed projects complied with Air Force policies and guidance, supported base master plans, and included accurate cost projections and thorough justifications. Following review by the working groups, the proposed program was reviewed again by the Ad Hoc Committee of the Installations Board. Higher echelons of review included the Installation Board, the Budget Advisory Committee, and the Air Council. Once these reviews were complete, the Air Force Public Works Program was subjected to review by the DoD, the Bureau of Budget, and then by the U.S. Congress. The estimated time for the preparation and review of an Air Force military construction program was approximately 10 months. The programming phase was followed by the legislative phase, during which the budgets and justifications were reviewed and approved by the U.S. Congress. Once the funds were authorized, projects were designed, approved, and contracts were issued for construction. The final phase of the process was construction and acceptance of the completed facility by the Air Force.[52]

Prior to 1950, approximately $310 million was appropriated to expand and to modernize Air Force bases. Approximately 20 percent of this total appropriation was available at the beginning of the Korean Conflict. By June 1951, appropriations rose to $1.65 billion and the Air Force had approximately $1 billion of work under contract. In the FY52 programming cycle, the Programs Branch of

Table 2.1 Air Force Military Construction Program Appropriations, 1951-1953

Appropriations	Amount	Date	Purpose
FY51 Basic Program	$139.8 million	September 1950	Tied to 48 wing force
FY51 1st Supplemental Program	$227 million	September 1950	Covered essential pavement upgrades, fuel storage and communications facilities for Air Defense Command interceptor fighters in CONUS and some overseas construction
FY51 2d Supplemental Program	$804 million	Fall 1951	Geared to 68-84 wing force
FY51 4th Supplemental Program	$282 million	May 1951	Anticipated 95 wing build up, expansion of 12 training bases, and overseas construction in the United Kingdom and Thule, Greenland
FY52 Basic Program	$102 million	Fall 1952	Basic Program
FY52 2d Supplemental Program	$2.071 billion	Fall 1952	To build up to 95 wings
FY53 Basic Program	$1.2 billion	Fall 1952	To build up to 143 wings

Source: Col. Robert H. Curtin, "Air Force Construction, Its Organization and Planning," Thesis submitted to the faculty of the Air War College, Air University, Maxwell AFB, Alabama, 1954, 96-102.

the Construction Division submitted an internal request for $7.7 billion to address deficiencies at Air Force bases and for construction required to accommodate the expanded Air Force size of 95 combat wings. During internal reviews, the Air Staff reduced this amount to $5.5 billion; the DoD further reduced the amount to $3.58 billion. The FY52 Air Force appropriation approved by Congress totaled $2.173 billion.[53] Table 2.1 presents Air Force military construction program appropriations between FY51-FY53.

The amount of funding appropriated for construction, the large number of facilities required, and continuous changes in base uses overtaxed the Air Staff procedures to program, design, contract, and monitor construction work. The announcement to increase the number of combat wings to 143 by 1955 prompted a comprehensive review of the current Air Force MCP in early 1952. Adopting the name Operation SNOWBALL I, the Air Staff, AFIR offices, and major command staffs reviewed the appropriated MCP budgets line by line and project by project and determined that half of the projects required revisions to support the increased number of combat wings and charges in base missions. Under Operation SNOWBALL II, design directives were revised and reissued. In fall 1952, construction projects were ready to be fielded. As a result of the FY52 program review, management controls were strengthened and funding restrictions imposed. Thorough justifications for expenditures were made mandatory and greater attention was paid to management and cost containment.[54]

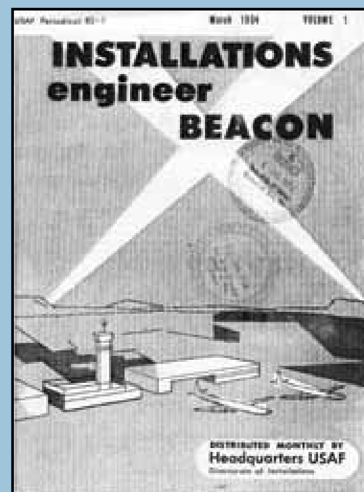
Time constraints for the preparation of the FY53 budget, submitted in April 1952, necessitated that expenditures be justified after the budget approval. The Air Force was afforded maximum flexibility in allocating the appropriation, provided that an average of $120 million in funds was contracted per month. Failure to meet this contracting average would result in a zero appropriation for FY54. Operation SNOWBALL III was activated to support this goal. Between October and December 1952, a total of only $265 million of construction contracts was awarded. In January and February 1953, the numbers of construction contracts rose as projects were cleared and design directives were sent to the field. However, the Eisenhower administration imposed a freeze on all construction projects in February 1953. Directed by the Bureau of Budget and the Office of the Secretary of Defense, the freeze affected all projects not yet under contract and projects under 20 percent completed. The purpose of the freeze was to review all programs for "essentiality." This review delayed Air Force construction projects for several months. As funding was released for contracting, the number of Air Force wings was revised downward to 127. This change in overall size of the Air Force necessitated yet another round of redesign and reprogramming of the available construction funds.[55]

During 1954-1955, the Air Staff worked to commit the $5 billion in funds appropriated between FY51 and FY53. In FY55, the MCP received a new authorization to expend $398.7 million and the authority to reprogram $436.5 million.[56] For the FY56 budget cycle, the Air Staff implemented a change in procedures. Beginning with this cycle, the Air Staff programmed complete project packages that included construction costs, as well as supporting costs for each facility. Supporting costs included such items as parking lots, sidewalks, and utility connection costs.[57] A further improvement in programming process was introduced with submittal of the FY61 MCP prepared in 1959. Each major command presented its program to the Air Staff MCP panel, which greatly assisted in justifying the overall program to the DoD and the U.S. Congress.[58]

Beginnings of a Professional Development Program

Maj. Gen. Lee B. Washbourne's vision for the Air Force installations engineers was one of professionalism. Civil engineers were "no longer just the plumbers and things like that. His vision was that the civil engineers were as important to the Air Force as other functions and they needed to build themselves up into that posture."[59] General Washbourne convened the first worldwide Installations Command Conference in November 1954 in Washington, D.C. Installations engineers from all major commands attended. The purpose of the conference was to familiarize all command engineers with the latest developments in personnel, equipment, construction, real estate, programming, maintenance, and related functions, as well as to facilitate discussion through question and answer sessions.[60] When the second worldwide conference was held in 1955, 72 officers and civilians participated in a three-day event.[61] General Washbourne also instituted a monthly newsletter for circulation among all installations engineers entitled the *Installations Engineer Beacon*.

Installations Engineer Beacon



During the mid-1950s, efforts were made to improve communication among Air Force engineers. One effort was the monthly newsletter entitled Installations Engineer Beacon. The first issue was published in March 1954. Assembled and published at Air Force Headquarters, the purpose of the newsletter was to "spread vital knowledge of the latest developments in the Installations Engineering field" to far-flung field personnel. The newsletter informed Air Force installations engineers about the latest policies, procedures and trends in planning, design and engineering, and facilitated the exchange of ideas and solutions to common challenges. The 8-to-12-page newsletter contained announcements of the publication of new regulations and updates in the areas of planning and programming, architectural engineering, construction, maintenance, and real estate. The newsletter was published monthly between March 1954 and August 1958. After that, the number of pages increased, but the frequency of publication decreased to every two to three months from late 1958 and through 1959. In February-March 1959, the newsletter was renamed Civil Engineering Beacon to reflect the new name of the Directorate of Civil Engineering. In all, 61 issues were printed between 1954 and 1959. In its final issue dated November-December 1959, the Beacon described its replacement, Air Force Civil Engineer, as "a new technical publication of professional caliber, aimed directly at the Civil Engineer throughout the Air Force."[62]

A major restructuring of the installations engineering officer career field occurred during 1955 and 1956. A study conducted in late 1955 found that professional training requirements in the installation officer career field were inadequate and that the field lacked Air Force Specialty Codes (AFSC) commensurate with its widely varied duties. As a result of the study, the AFSC 5524-Installation Officer was withdrawn and replaced with five new AFSCs: 5525-Installations Engineer; 5534-Construction Engineer; 5544-Maintenance Engineer; 5554-Utilities Engineer; and, 5564-Planning Engineer. Brig. Gen. C. Brown Pratt, Deputy Assistant Chief of Staff, Installations, praised the expansion of the career field classifications. The move, he said, was designed to "give more professional status to our Installations Engineers, provide higher educational opportunities for them and generally make our career field more attractive [for recruitment]. We also expect that these changes to the career field will identify our engineering talents and enable us to better classify our people, better assign them and get the right man on the right job."[63]

The new AFSCs carried the requirement that officers have a Bachelor of Engineering degree. An advanced degree in either engineering or management became a prerequisite for advancement in some fields. By 1958, only 46 percent of officers held bachelor degrees and only 5 percent of officers had advanced degrees. Another study of the Air Force civil engineer career field revealed an imbalance between the numbers of military and civilian personnel. A plan to correct the problem within three years was developed. The plan was designed to make the installations engineer officer and Airman career fields more attractive in an effort to retain personnel. The study also revealed an imbalance between low and high skill level authorizations in CONUS to support overseas requirements.[64]

The focus on increasing professionalism in the career field intensified after Maj. Gen. Augustus M. “Gus” Minton was appointed Director of Installations in July 1957 and continued through his tenure as Director of Civil Engineering. General Minton transferred to the position after serving as base commander at Chanute AFB, Illinois. Though educated as an engineer, General Minton received a Bachelor of Science degree in education. He held a Master of Science degree in business administration conferred by the Harvard Business School. General Minton also was a registered mechanical engineer. During World War II, he was instrumental in building the Army Air Corps training program. He then served as deputy chief of staff of administration for the Twentieth Air Force stationed in Guam.[65]

During his tenure, General Minton continued the worldwide conferences. Beginning in 1958, the worldwide conferences were held at Ramey AFB, Puerto Rico. General Minton also established the new professional publication entitled *Air Force Civil Engineer*. He led a concerted effort to instill all civil engineers with the values of professional development, higher education, continuing education, and professional registration. Reflecting on the training level and role of civil engineering, General Minton noted “a frightening decline in educational quotient of our people, and it has become evident at a time when the volume and complexity of the Civil Engineering tasks are increasing profoundly. The situation has become quite serious; for I regard education, competence and capability as somewhat synonymous.”[66]

On November 20, 1958, General Minton, at the direction of Headquarters U.S. Air Force, inaugurated a formal professional development program. In a letter to all major commands, General Minton requested each major command civil engineer “to undertake and pursue an active plan to have our eligible engineers become registered as Professional Engineers and affiliated with professional societies.”[67] The professional development program was a major topic at the 1958 World-Wide Installations Engineer Conference held at Ramey AFB, Puerto Rico. There, Col. Clarence A. Eckert, Director of the

A group photo from an early Air Force Civil Engineer worldwide conference at Ramey AFB, Puerto Rico.

Installations Engineer School at Wright-Patterson AFB, Ohio, outlined a program which comprised four components:

1. Establishment of professional goals and standards;
2. Improved availability of educational opportunities to reach established standards;
3. Control over input and upgrading of all officers; and,
4. Effective utilization of skills obtained through professional education.[68]

In 1959, the Air University Civil Engineering Center unveiled two resources to support officers and civilians interested in formal registration as Professional Engineers. The center targeted recent engineering graduates and engineers active in the Civil Engineer career field; both were encouraged to prepare for the State Professional Engineer Examination, to qualify for an Engineer-in-Training Certificate, or to pursue a Professional Engineer License. One resource offered by the center was a two volume “Self Study Guide;” the second resource was professional engineer preparatory courses. The study guide was intended for those requiring a refresher course to prepare for the exam. The guide offered general information on applying for registration as well as sample questions gleaned from state exams.[69]

Preparatory courses covered conventional engineering topics. Students selected from a variety of courses, depending on their interests and needs. One group of courses was categorized as refresher courses and included electricity II, hydraulics II, mathematics and measurements II, and a course in reinforced concrete. The second group of courses focused on the application of engineering principles and included chemical engineering, civil engineering, electrical engineering, and land survey. A course in engineering economics and practice was recommended to students, since the subject applied to many aspects of engineering covered in the examination. Students and practicing engineers were supported as they prepared for professional registration. They were encouraged and afforded the guidance necessary for registration to be an achievable goal.[70]

BUILDING THE PERMANENT BASES

On June 30, 1950, the 210 Air Force installations supported 48 groups. By June 30, 1951, the Air Force maintained 232 major installations and was requesting authorization for 77 additional bases to accommodate the 95-wing program. When the expansion to a 143-wing Air Force was announced in late 1951, the Air Force found itself “sadly behind in its installations, both in the United States and abroad.”[71] The inventory of CONUS bases included the 232 active air bases, 33 industrial plants, 45 inactive bases, and 14 excess bases; 85 bases were located overseas. Only a handful of permanent air bases in CONUS were constructed prior to World War II. Most World War II air bases were designed for training and not suitable for conversion to operating bases, particularly for highly specialized SAC and ADC facilities. In addition, surviving World War II air bases were not strategically located to support then-current national air defense objectives or within efficient striking distance of potential enemy targets.

The building stock on the World War II bases comprised temporary wood-frame mobilization buildings, which did not meet the design criteria to support the sophisticated aircraft in use by the modern Air Force of the early 1950s. High-performance jet aircraft, long-range heavy bombers, and military transport aircraft required long runways, strong pavements, large taxiways and parking aprons, runway overruns, long clear zones and established approach corridors, and large hangars; these features were not available on the World War II temporary bases. Fuel consumption rates of high-performance aircraft were nearly three times that of World War II aircraft necessitating large fuel storage facilities and high-speed refueling systems. In addition to operating bases, modern training bases also were needed with facilities for individual and combat crew training, including classroom buildings, and link, bomb, and navigational trainers. Troop and family housing, operating and administrative facilities, medical facilities, and shops also were required to support the modern Air Force. New facility design criteria also included climate controls, advanced fire suppression systems, and noise controls. Applying the minimum requirements for contemporary air bases, every CONUS and overseas base required substantial expansion and/or facility improvements to accommodate new aircraft, new missions, and the new Air Force. The first base to be developed following modern design criteria was Limestone AFB, Maine (renamed Loring AFB in 1954), which was under construction in 1950.[72]

Air Force Installations Representatives

The U.S. Army Corps of Engineers or the U.S. Navy acted as construction agents for the Air Force MCP. The MCP relied entirely on contracts with architect-engineer firms and construction firms to execute projects. Ninety percent of Air Force construction was contracted through the U.S. Army Corps of Engineers. Approximately 85 percent was handled by state-side district Corps offices, while the remaining 5 percent was administered through overseas Corps offices, such as the Joint Construction Agency in Europe or the Okinawa Engineer District in Japan. The remaining 10 percent of Air Force construction was administered through Air Force major commands, primarily the Air Materiel Command (AMC), the Far East Air Forces (FEAF), and the U.S. Air Forces in Europe (USAFE). AMC contracted directly with firms for the construction of specialized test facilities, such as engine test cells and other highly technical maintenance facilities.[73] As the 1950s progressed, the Bureau of Yards and Docks of the U.S. Navy assumed approximately 10 percent of the Air Force construction program.[74]

Air Force Installations Representatives (AFIR) served as liaisons between Air Force units, which developed the project construction requirements, and the construction agents, who contracted the work. Known as Air Force Liaison Officers during World War II, the AFIRs played an increasingly important role in executing the Air Force MCP. The AFIRs' primary responsibility was to ensure that funds appropriated through Congress were used properly and that Air Force construction was completed according to specifications and within budgets. The AFIR offices originally were co-located with the U.S. Army Corps of Engineers District offices. During 1951, 10 AFIR offices were operational and located in Boston, Massachusetts; New York, New York; Atlanta, Georgia; Cincinnati, Ohio; Omaha, Nebraska; Dallas, Texas; Portland, Oregon; San Francisco, California; Casablanca, Morocco; and, Anchorage, Alaska.

Staffing levels were increased substantially. In 1950, 13 officers and 8 civilians served as liaison officers; by May 1951, AFIR staff was increased to 64. By the end of 1951, AFIR field offices were manned by 60 officers and 65 civilians. Field offices typically were directed by a Colonel who oversaw an average of 7 officers and 13 civilians. Additional AFIR offices were established to meet growing construction demands related to the Korean Conflict.[75]

In March 1952, AFIRs were placed under the Operations Branch in the Construction Division within the Directorate of Installations; the following month, AFIRs were re-aligned to report directly to the Chief of the Construction Division.[76] Among the responsibilities vested with AFIRs was the "authority for the approval of site location plans, preliminary construction plans and outline specifications for Air Force construction financed from 'acquisition and construction of real property' funds."[77]

In 1952, the Vice Chief of Staff for the Air Force authorized an expanded number of AFIR offices and increased the staff size. This action raised the number of personnel in AFIR field offices to 77 officers and 129 civilians to keep pace with the increased construction demands. A new office was established in Paris. The duties of the AFIR offices were expanded on 10 March 1952. AFIRs were given the final review authority for preliminary plans and specifications, and authorized to approve line item cost modifications to awarded contracts within a 20 percent ceiling.[78]

AFIR responsibilities were codified in Air Force Regulation (AFR) 93-17, which was first issued in December 1953, and re-issued in 1954. Selected responsibilities detailed in this AFR were:

- General field surveillance of construction being carried out by a construction agent;
- Assigning priorities to the construction agent;
- Ensuring that Air Force design criteria were received by the construction agent;
- Approving site selection for facilities in accordance with installation master plans;
- Reviewing installation master plans;
- Coordinating all phases of design and planning of facilities with the construction agent and major commands;
- Approving preliminary construction plans and cost estimates;
- Reviewing bidding documents;
- Authorizing and approving design and program adjustments and change orders;
- Conducting field visits to monitor construction progress;
- Maintaining adequate and continuous surveillance of project costs; and,
- Reviewing monthly reports on the progress of maintenance projects for installations.[79]

A major addition to AFIR responsibilities was writing design instructions for the construction agents. While this function increased the workload within the offices, it also increased efficiency in communicating directly with the construction agents. The South Atlantic AFIR was the first office to issue a written design instruction in April 1954. By June 30, 1954, that office issued over 390 design instructions and/or modifications for 825 line items for new construction. AFIRs also became more involved in the overall programming process. AFIR personnel assisted base and major command personnel in developing program submissions, project siting, and design criteria. AFIRs were heavily involved in formulating the FY55 and FY56 military construction programs. The advance knowledge

Members of the Air Force Installations Representative Office, Southwestern Division, Dallas, Texas, 1954.

of proposed projects gained through this involvement was an advantage to the AFIRs once funds were approved to contract selected projects.[80]

By 1954, AFIR offices were located in the Missouri River Region, New England Region, Ohio River Region, Southwest Region, South Atlantic Region, North Atlantic, North Pacific Region, South Pacific Region, East Ocean Division, and Mediterranean Division.[81] As the range of Air Force construction programs expanded, so did AFIR responsibilities. Additional programs included the construction of communications stations and family housing.[82] AFIR responsibilities in the family housing program extended to the coordination of real estate acquisition, approval of siting, consultation on utilities requirements, and technical advice on engineering problems.[83] In 1959, AFIR was renamed Air Force Regional Civil Engineer (AFRCE).

Construction Programs

All major commands required the addition of new installations or new or improved facilities at existing air bases to execute their missions. Between 1951 and 1953, the Air Force MCP was allocated over $5 billion in appropriations. Of this total amount, 56 percent was spent in CONUS and 46 percent was spent for construction overseas. Fifty-five percent was spent on permanent construction while the remaining 45 percent was directed towards temporary facilities.[84] A breakdown of Air Force expenditures per dollar is detailed in Table 2.2. In CONUS, work in the Northeast and Atlantic areas accounted for a higher percentage of the total construction budget.[85] In 1951, the Air Force MCP was compiled on a few sheets of letter-sized paper. By 1954, the Air Force MCP comprised "volumes of machine record productions that listed the hundreds of locations and the scores of line items of construction" planned for each location.[86]

The Directorate of Installations formulated construction standards, definitive designs and outline specifications, installations facilities requirements, standard nomenclature and coding for facilities, and costing instructions to manage the MCP during the early 1950s. Permanent construction was defined based on a life expectancy of 25 years. The useful life of semi- permanent construction was 10 years. These construction standards were introduced in the FY51 2d Supplemental Program.[87]

The development of definitive designs and outline specifications supported the Air Force MCP. The first design manual for standard definitive designs was issued by the Architectural Branch of the Construction Division in 1950.[88] In 1951, the Architectural Services Branch of the Directorate

Table 2.2 Typical Air Force Construction Dollar (FY50-51)

Airfield pavements	20 cents
Liquid fuel storage/dispensing facilities	8.9 cents
Communications, navigation aids facilities	4.6 cents
Operational and training facilities	17.5 cents
Maintenance facilities	2.1 cents
Troop Housing/messing	15.9 cents
Family Housing	2.2 cents
Utilities	12.9 cents
Real estate acquisitions	1.3 cents
Medical facilities	2.9 cents
Storage facilities	6.2 cents
Operational Shops	1.6 cents
Administration and community facilities	3.9 cents
Total	$1.00

Source: Col. Robert H. Curtin, "Air Force Construction, Its Organization and Planning," Thesis submitted to the faculty of the Air War College, Air University, Maxwell AFB, Alabama, 1954, 107.

of Installations released definitive design drawings developed by Mills & Petticord. The U.S. Army Quartermaster Corps historically employed standardized designs during peacetime for a variety of permanent common cantonment buildings. Standardized plans also were developed by the U.S. Army Corps of Engineers during World War II for temporary mobilization construction to facilitate rapid construction and economy in materials. The purpose of Air Force definitive drawings was to develop standardized floor plans, building requirements, and space allotments to guide final design and construction. The definitive drawings and outline specifications provided the Air Force instructions to the U.S. Army Corps of Engineers and to the architect under contract for each project. Architects selected for projects were responsible for developing site plans, working drawings, utility layouts, and detailed specifications. The outline specifications provided general guidance for the selection of building materials within the parameters of function and budget. Functional and efficient designs without embellishments were preferred. Prefabricated construction was encouraged, as well as the use of new materials and construction methods. The Outline Specifications in Air Force Manual (AFM) 88-15 also directed:

> It is not considered essential that new structures conform with the established style at existing installations. It is desirable instead that the designs be consistently economical and generally in harmony with the simple contemporary architectural trends, devoid of any details or ornamentations, applied purely for the sake of embellishment. Full advantage should be taken of the use of the natural textures and color of the materials employed as well as of the variety afforded by the properly selected color schemes where paint is applied.[89]

Definitive designs were issued for common building types found at typical Air Force bases. These building types included dormitories, mess halls, guardhouses, chapels, theaters and administration buildings. Operations buildings included a wide range of buildings to support new aircraft. Unlike the single, all-purpose hangar design used throughout World War II, definitive designs were prepared for various hangar types: alert, readiness, double cantilever, and nose. New building types included the armament and electronics building, aircraft maintenance building-engine build-up building, and celestial navigation trainer building. Specialized building types included communications buildings, operations buildings, and technical training buildings. Designs for the range of building types were developed using modern materials with minimal ornamentation.[90] The definitive designs were distributed to all U.S. Army Corps of Engineers district offices and AFIRs. Definitive designs were implemented with the FY51 construction program and published in AFM 88-2.[91]

Following the Korean Conflict, the Air Force's definitive designs were substantially revised based on field experience and peacetime facilities requirements. In December 1954, the Assistant Chief of Staff, Installations initiated the review of existing definitive drawings and the preparation of revised definitive drawings and standard working drawings, as appropriate. The revised plans emphasized improved livability standards and more aesthetically pleasing architectural designs for personnel support buildings, including dormitories, chapels, post exchanges, theaters, and other community buildings. In 1956, 200 definitive drawings were scheduled for development or revision by the seven architect-engineer firms engaged in the program. The architect-engineer firms prepared definitive working drawings and other studies to support the development of designs for facilities included in the MCP. Definitive designs were prepared for standard Air Force family housing, hospitals, Air Force Reserve facilities, and support facilities for guided missiles and other engineering structures. New and revised design criteria also were released for alert hangars, shelter ready fighter aircraft, maintenance docks, and aircraft weapons calibration shelters. By mid-1957, nearly all the definitive drawing designs were completed, approved, and distributed to field agencies. Units in the field reported that the drawings were satisfactory and contributed to substantial savings in construction costs.[92]

Selection of the appropriate plans from the definitive drawings for construction on specific air bases was guided by the publication entitled *USAF Installations Facilities Requirements* issued in July 1951. The requirements book specified facilities by mission and base function.[93] The book contained data on the quantitative fixed facility requirements for specific missions at Air Force installations. These data were used throughout the Air Force as a yardstick for developing the FY53 budget. This publication was continuously revised.[94]

Standard nomenclature was introduced to facilitate consistent recordkeeping for the entire Air Force construction program using business machines. The nomenclature was published in AFM 93-2: *Installations Facilities and Structures Manual*, which was retitled in 1956, *Real Property Standard Codes and Nomenclature.*[95]

Accurate cost estimates were critical in managing the Air Force MCP. Budgeting concerns included estimating methods and the calculation of cost escalations to adjust budgets for cost increases from the construction estimate and actual construction. Initially, national average unit costs were adopted; these averages were later refined to account for area cost factors. Overseas construction was linked to an overseas cost index. In some situations, on-the-ground costing methods were employed by the U.S. Army Corps of Engineers and the AFIRs.[96]

The MCP and operations and maintenance funds financed new construction and modernization programs instituted by the Air Force in response to changing mission requirements. As the 1950s progressed, several major factors affected the construction program. One was the 1954 adoption of the Emergency and Long-Range Dispersal policy that affected the positioning of SAC and ADC units in the United States. The objective of this policy was to reduce the vulnerability of U.S. aircraft to enemy attack by limiting the number of aircraft at each base and by widely dispersing units at strategically located air bases. The dispersal strategy was intended to increase the number of intact aircraft available to launch in a retaliation following a nuclear attack. New air bases were required to adhere to this policy, particularly in the northern United States. In April 1955, a program was proposed to implement the Emergency and Long-Range Dispersal policy. The proposed program would disperse the strike force based on a formula of one heavy bomber squadron per base or one medium bomber reconnaissance wing per base; SAC, alone, needed 34 new bases for implementation of the program. The total estimated construction cost for the 69 new installations necessary to support the complete program was $786 million for facilities and $58.5 million for family housing. Air bases were examined for their potential to support multi-mission capabilities.[97]

The Air Force also worked to upgrade and modernize airfields throughout the 1950s. Runways and support facilities were vital to all Air Force operations. During the 1950s, runways were reconfigured radically and support facilities were expanded. The intersecting runway configurations favored prior to 1945 were replaced by straight runways of greater length. Jet aircraft required runways measuring 200 feet wide by 10,000 feet long, while bombers required runways measuring 300 feet wide and extending 11,000 feet. In the early 1950s, asphalt was the primary material used to construct permanent runways. As new aircraft exceeded the weight limitations of the material, the asphalt runways failed. The largest aircraft flown in World War II, the B-17, weighed 75,000 pounds, while the B-52, which entered service in 1955, weighed over 385,000 pounds. Aircraft tire pressure increased from 65 pounds per square inch to 300 pounds per square inch for some aircraft. In addition, heat blasts from jets caused pavement to break down and broken pavement damaged aircraft engines. Fuel spills contributed to asphalt failure. In response to these problems, the Air Force unveiled a policy on January 18, 1956 to build all primary airfields in concrete using Portland cement. On May 25, 1956, airfield pavement criteria were refined to incorporate standards for heavy duty load pavement. Such pavement accommodated a dual-tire B-52 aircraft weighing 456,000 pounds. Runway construction was expensive and often reached $3 million per air base. Air Force civil engineers examined the problem and proposed a cost effective solution. Engineering requirements did not mandate a consistent concrete thickness throughout a runway. A successful structure only needed a thick center keel of approximately 50 feet

Barracks constructed in 1959 at Selfridge AFB, Michigan.

in width and keels of similar dimension along each side of the runway to support wing gear. This design modification saved money and reduced downtime for base operations.[98]

Modernization of Airmen dormitories was another long-term project initiated by the Air Force civil engineers. Until the 1950s, Airmen occupied traditional Army barracks. Airmen lived in large, open squad rooms and shared communal showers and bathrooms. The Air Force Directorate of Installations campaigned for quarters affording privacy and an end to communal bathrooms. SAC designed and constructed a barracks prototype in steel with semi-private baths shared by flanking rooms. The Air Force requested permission from the DoD to develop a masonry version of the SAC dormitory. The DoD initially granted approval to the Air Force and a finite number of new style dormitories were constructed between 1953 and 1955.[99]

In 1955, the DoD completed a tri-service study of dormitories and rejected the dormitory design with bathrooms flanked by dorm rooms. The ceilings for dormitory construction in FY55 were $1,700 per man for permanent and $1,400 per man for semi-permanent dormitories.[100] The Air Force continued to argue for modern dormitories. The DoD authorized the Air Force to procure bids for two dormitory designs, including the SAC steel type dormitory, at three representative locations. Construction bids for the preferred Air Force option, masonry dormitories with bathrooms flanked by dorm rooms, were the lowest bids received for two sites. In March 1957, the Assistant Chief of Staff, Installations presented the cost evaluation of all bid abstracts to the DoD with the request for authorization to proceed with construction of the masonry SAC type dormitory. The Secretary of Defense ultimately denied the request.[101] In 1959, the Directorate of Installations again requested permission to construct dormitories with semi-private baths as opposed to the traditional communal toilets. The DoD authorized a pilot project to secure cost data for the two designs through competitive bid. The pilot study revealed that construction costs for dormitories with semi-private baths were $2,018 per man versus $1,823 per man for communal toilets.[102]

Since permanent replacement dorms were removed from the MCPs, the Directorate of Installations initiated an extensive modernization program for existing facilities. In early 1959, a prototype dormitory modernization project was underway at Bolling AFB, Washington, D.C. A Barracks Modernization

Program further was developed in fall 1959, from requirements identified by the major commands. The objective of the program was to produce high standard living quarters for Airmen at approximately half the cost of new construction. In 1959, 386 buildings containing quarters for 15,109 men were modernized at a cost of $15 million secured from the O&M appropriation.[103]

Air Force civil engineers also pushed for the use of pre-fabricated buildings during the 1950s. In 1951, a study was conducted to assess the utility of pre-fabricated structures; it was concluded that such structures were suitable for shops, warehouses, and general purpose buildings. By the end of the 1951, 1,200 prefabricated structures were purchased at a cost of $3.3 million and installed. Policies for appropriate use and revised criteria for pre-fabricated buildings were formulated during 1953 and published in 1954.[104]

SPECIAL PROJECTS

Air Force civil engineers at the directorate and major command levels were involved in planning, programming, and monitoring for a variety of special projects throughout the 1950s. These projects included family housing, communications facilities, missile facilities, and the U.S. Air Force Academy. In some cases, such as family housing and the U.S. Air Force Academy, Air Force civil engineers assumed responsibility for all aspects of the project. In others, they served as part of the team that planned and supported the completion of facilities critical to U.S. national security. In all cases, Air Force civil engineers managed and maintained all facilities that were encompassed under the Air Force mission.

Wherry and Capehart Family Housing Programs

Following World War II, military service personnel faced severe family housing shortages. Several factors contributed to this shortage. One factor was the increased number of personnel required to maintain the post-World War II permanent U.S. military establishment. These numbers were much larger than in any previous time of peace. At the same time, the number of families increased, particularly after the higher ranks of enlisted personnel were allowed to serve accompanied by families. In addition, personnel serving in the Air Force supported increasingly sophisticated weapons systems that required high levels of technical skills. Providing military family housing comparable to contemporary civilian housing was one strategy used to attract and retain qualified personnel in military service.[105]

The newly created Air Force had the least number of family housing units at air bases. In 1949, the Air Force inventory contained 17,954 family housing units at its air bases; 6,397 of these units were deemed substandard. In comparison, the Air Force estimated that 121,000 family housing units were required to house its personnel. This housing had to be supplied against the backdrop of supplying an estimated 20 million homes to the civilian population over a twenty-year period. By 1949, only 5,225 new housing units had been constructed for the Air Force through Congressional appropriations, and the necessity for a new housing program was recognized fully.[106] The Air Force Family Housing program of the 1950s became the largest housing effort ever directed by a single Federal entity.[107]

The military family housing shortage attracted the attention of Senator Kenneth Spicer Wherry of Nebraska when military installations located in his state were affected by the housing shortage. On February 21, 1949, Senator Wherry proposed a bill to encourage private sector developers to construct military family housing. Wherry's bill authorized the Federal Housing Administration (FHA) to insure private rental housing on or near permanent military installations. Previously, the FHA had determined that rental housing developments near military installations presented unacceptable mortgage risks due to continuous military transfers and the uncertain status of military installations. Senate Bill 1184 established a Military Housing Insurance Fund administered by the FHA to underwrite loans for projects near military installations certified as meeting a genuine need for housing at a long-term installation where no personnel cuts were anticipated. Senate Bill 1184, Wherry Act, was signed into law on August 8, 1949 by President Harry S. Truman and extended to July 1, 1951.[108]

While Congress debated the Wherry Act, the Air Force developed guidelines during 1949 to implement the anticipated legislation. Many of the preliminary guidelines were codified formally in AFR 93-7, *Installations-Control Procedures, Air Force Implementation of Title VIII of the National Housing Act*. The AFR outlined responsibilities for all parties involved.[109]

Once the Wherry Act was officially adopted, installation commanders appraised their base housing situations and estimated the number of Wherry units needed to satisfy housing demand based on current and past demographics. Air Force installations were found eligible for the program following formal approval by the Vice Chief of Staff of the Air Force and high-level deputies. The Housing Office in the Directorate of Installations monitored the program closely. Initially, 39 Air Force installations were selected for the program. Following formal approval, bids were solicited to construct Wherry projects. Private contractors were selected based upon the proposal that best met cost and design requirements. Initially, the U.S. Army Corps of Engineers acted as the construction agent and manager for Air Force projects. In November 1953, the Air Force successfully lobbied to transfer responsibility from the U.S. Army Corps of Engineers to the Secretary of the Air Force. Under DoD Directive No. 4165, the Air Force assumed responsibility for selecting successful bids and for contracting for architect-engineer services for Wherry housing projects. These responsibilities included preparing bids, soliciting bids, and processing payments to architect-engineer firms. The process authorized under DoD Directive No. 4165 expedited schedules and reduced overhead expenses by about $5,000 per project.[110]

The majority of Wherry housing was constructed on government-owned land that was leased to the sponsor for a period of 50 to 75 years. The sponsor owned and maintained the Wherry units, which were not classified as government housing. Military personnel rented the Wherry units using their base housing allowance.[111] The average size of a Wherry housing unit was 959 square feet. The first Wherry project comprised 250 units at Maxwell AFB, Alabama, which were constructed in 1950. By August 31, 1951, the Air Force inventory included 9,050 Wherry family housing units; an additional 17,788 units were under construction.[112] By June 1954, 33,217 Wherry family housing units were added to 55 Air Force installations. An additional 800 units were sponsored prior to the expiration of the Wherry Act on June 30, 1954.[113]

Notwithstanding the construction of Wherry housing units, the Air Force still confronted a family housing shortage due to manpower levels necessitated by increased Cold War tensions. Senator Homer Earl Capehart of Indiana sought to correct shortfalls identified in the implementation of the Wherry

Wherry Housing constructed in 1956 at Mt. Home AFB, Idaho.

Act and to renew private sector interest in investment in housing for the military. The Capehart Act was signed into law on August 11, 1955. Under the Capehart Act, family housing was constructed on government-owned land and completed units were turned over to the government for administration as public quarters.[114]

The DoD required that all military branches purchase Wherry units from the sponsors under the Wherry Acquisition and Rehabilitation program enacted in 1956 prior to the initiation of the Capehart housing program. Col. Rio G. Lucas, chief of the Family Housing Programming Branch from 1957 to 1962, explained, "When we realized we weren't getting the kind of service out of contractors who owned them for maintenance and upkeep, we decided to try to buy them…. They just didn't get any kind of maintenance at all and were in very bad shape."[115] By December 30, 1959, the Air Force had acquired 31,380 Wherry units and Congress allocated $3.6 million for acquisition of an additional 1,754 units.[116] Wherry housing construction often was substandard due to the modest budgets established by the legislation. Once acquired, the Wherry housing units were upgraded to accommodate more amenities. Congress ultimately appropriated $70 million for all military branches to renovate Wherry housing through the Wherry Rehabilitation and Improvement program.[117]

Col. (later Maj. Gen.) Guy H. Goddard was assigned to the Air Staff in 1957 to lead the family housing division. He was given strict orders by Maj. Gen. Augustus Minton, Air Force director of Installations,

> I told him, in just a few words, that we wanted every dollar spent on every house that you could spend on it. We wanted to get them air-conditioned where they should be air-conditioned. In those days, there was a line of demarcation drawn for air conditioning. I told him, "Do whatever we can to get that changed. We don't want any straight streets; make them curved." The [U.S. Army] Corps of Engineers would build them straight. "We don't want the houses all white. We don't want any gaudy colors, but tasteful blending, with winding streets."… He worked out very well. We had the best housing program—there's no question about it, air-conditioning, and so forth. And the other services complained.[118]

General Goddard's assessment of the available military housing inventory was not favorable. The oldest housing stock was inherited from the Army and comprised masonry houses constructed between the late nineteenth century and the 1930s. The 35,000 Wherry units "were built under a very low standard…and were in need of renovation and air conditioning."[119] General Goddard became the foremost advocate for improving Air Force family housing and earned the moniker, "Mr. Family Housing." Maj. Gen. William D. Gilbert, director of Engineering and Services from 1978 to 1982, noted, "[General Goddard] did more for housing in the Air Force than any other human has done in the history of the Air Force."[120]

The Air Force, through the Housing Office, supervised all facets of the Capehart housing program rather than relying on the services of the U.S. Army Corps of Engineers. The Air Force established the general design criteria, including site design, exterior design, interior layout, construction standards, and utilities. The Air Force established the number and types of housing based on occupant rank required at each air base.[121] The process was successful according to Colonel Lucas, who summarized the Capehart housing program,

> We would advertise for architects and engineers from the region where the housing was going to be built, so that we would be able to get the right kind of construction for the climate and for the area. We would have a review committee and select the architect/engineers, and we would indicate the area and the number of houses we needed and what the types would be, based on the rank that would be living in those

Rows of Capehart Housing constructed in the late 1950s at Vandenberg AFB, California.

> houses. Then we would get them to draw up the plans. And then we would advertise for a civilian contractor, generally again in that area if we could.[122]

Commanding officers continued to review and to manage the projects through the construction phase. During 1959, nearly 22,000 Capehart units were erected at Air Force bases.[123] When the Capehart housing program expired in 1962, the number of housing units added to the Air Force inventory totaled 38,014 Wherry and 62,816 Capehart units.[124]

Radar and Communications Facilities

Air Force civil engineers were called upon to support the construction of a series of complex radar-based detection and warning systems, which were developed in response to increasingly sophisticated military armaments. From the early years of the Cold War to the mid-1950s, the threat of Soviet attack evolved from that posed by World War II-era bombers armed with conventional weapons to the threat posed by hundreds of turboprop and jet bombers armed with nuclear weapons attacking from different directions. Early detection of potential attack became critical to U.S. national defense. The communications technology to support the early warning mission advanced rapidly. The sophisticated communications systems necessitated that civil engineers design and oversee the construction of complex facilities and infrastructure. The establishment of several networks of radar facilities represented a national investment of billions of dollars and presented significant construction challenges, particularly for construction in remote arctic areas.

Aircraft Control and Warning (AC&W) Sites

The earliest detection system, the Radar Fence Plan, was designed in 1947 and comprised a series of 85 radar stations and 11 warning centers located in CONUS and Alaska. President Truman signed Public Law 30 on March 30, 1949, authorizing $85.5 million to construct this system of aircraft control and warning stations. Congress appropriated an additional $54.3 million in October 1949, and construction was initiated in accordance with an aggressive schedule approved by the Joint Chiefs of Staff. At Headquarters, U.S. Air Force, the Architectural Branch of the Construction Division at the Directorate of Installations oversaw preparation of the criteria and definitive plans for the stations. Most sites were built under contracts awarded to the private sector; the U.S. Army Corps of Engineers in cooperation with the AFIR offices managed the construction effort.[125]

Construction of the AC&W sites went into high gear following North Korea's attack on South Korea in June 1950; the majority of the sites were completed by the end of 1950. Work in Alaska, however, lagged behind construction in CONUS. Site selection proceeded slowly due to the rugged terrain. Construction was plagued by obstacles. One contractor's financial failure forced contract changes and substantial budget increases to correct construction deficiencies, mainly in heating systems. Three AC&W sites were located north of the Brooks Range and were built by the Navy. Despite these challenges, 12 stations in Alaska were operational in 1953 and an additional 10 stations were completed by 1955.[126]

Each AC&W site comprised a complex of 10 to 15 wood-frame buildings that were connected by enclosed passageways. The buildings included geodesic radar domes known as radomes, operations and administrative space, dormitories, a power plant and utilities, and storage for fuel, food, and supplies.[127]

Special Category Army Personnel with Air Force (SCARWAF) troops built two AC&W sites in the interior of Alaska. The 813th Engineer Aviation Battalion built the three-way tropospheric relay station located atop Mt. Sparrevohn, 200 miles west of Anchorage, to link the sites on Big Mountain, Aniak, and Tatalina. The site, perched on the 3,400-foot peak, was accessible only by air. In June 1951, Engineers, who had been transported by helicopter, used an air-dropped D-4 bulldozer to carve out a runway. The cleared airstrip sloped 12 degrees and a sheer cliff marked one end. Because the area was so poorly mapped, survey equipment was dropped on the wrong summit at least once. On another occasion, a D-9 Caterpillar was hurled onto the top of the mountain during an air drop when the lowering cable snapped. Despite difficulties, the 813th completed work in just six months, and the mobile radar went into operation on December 13, 1951. Five days later, 100-mile-per-hour winds blew the antenna down. Geodesic domes were constructed to protect the radar sites from future damage.[128]

The 807th Engineer Aviation Battalion established the radar site on top of Indian Mountain, Alaska. An existing airstrip that had once served a gold mine was upgraded and an eight-mile road to the mountain top radar site was built. Construction began in July and was completed in November 1951. The SCARWAF units completed the Indian Mountain and Sparrevohn sites for a unit price of $1.5 million, approximately half the cost of sites built by private contractors.[129]

Although the majority of AC&W stations were built in the United States, these sites were part of a worldwide radar warning network that included facilities in many other countries. Ten stations were built in the Northeast Command area in Canada. In Asia, 25 radar stations were built in Japan and another six on Okinawa and outlying islands. In North Africa and the Middle East, construction of 28 stations was approved for French Morocco, Libya, Algeria, Tunisia, and Saudi Arabia. Another 12 sites were built in Spain, 4 in Iceland, and 3 in Greenland. The U.S. Army Corps of Engineers and AFIR offices were involved in these projects, all of which were completed by 1954. Stations were also a high priority for the Special Projects Branch in the Assistant Chief of Staff, Installations. Regular quarterly field conferences, attended by Air Defense Command, the AFIRs, the U.S. Army Corps of Engineers, and Headquarters, U.S. Air Force representatives, were held in each Air Defense Force area beginning in July 1954. These conferences were very effective in speeding completion of the entire AC&W program.[130]

Construction of the Pinetree Line, another series of radar warning sites, was undertaken as a joint program with the Canadian Air Force, which partnered with the United States to build the radar detection facilities and to train and equip effective air defense squadrons. The Pinetree Line comprised 33 stations built across southern Canada to support warning and ground control/intercept activities. The United States funded 22 stations; 12 were financed by the Canadians. The U.S. Army Corps of Engineers contracted for the construction of 10 stations in northeast Canada. All were completed by 1954.[131]

Distant Early Warning (DEW) Line

The DEW Line was yet another joint U.S.-Canadian radar system. Construction of the system faced formidable challenges due to its location inside the Arctic Circle to provide the earliest possible advance warning of an attack. The DEW Line followed an irregular path approximating the 69th parallel from Cape Lisburne on the western coast of Alaska below Point Barrow, across the northern reaches of Canada to Cape Dyer on the east coast of Baffin Island near Greenland. It was the largest construction project ever attempted in the arctic.[132]

In December 1953, the Air Force awarded a contract to Western Electric Company (WECO), a subsidiary of the Bell System, to manage the entire project, including all site construction and installation of equipment. The Office of the Secretary of Defense approved a Management Fund for all project funds, with an initial construction authorization of $42 million. The project became a primary effort of the Special Projects Branch in the Assistant Chief of Staff, Installations, which was tasked with accelerating construction for the radar program in 1954. The deadline for transfer of the DEW Line to the Air Force was July 31, 1957. The estimated cost of the system was almost $400 million.[133]

Working with the Lincoln Laboratory of the Massachusetts Institute of Technology, the Air Force conducted preliminary tests in the vicinity of Point Barrow, Alaska, to determine the feasibility of constructing the DEW Line so far north. In early 1953, airfields were scraped into the ice and snow so that cargo planes could deliver tractors, machinery, building materials, and other supplies. When the ice broke in summer, the Navy transported the bulk of the construction materials by sea through the Bering Strait. Work began on six preliminary radar stations in August 1953; the stations were completed and tested by the end of 1954. The results were promising, and work continued.[134]

The Assistant Chief of Staff, Installations provided programming and planning support. Rufus D. Crockett, who then served as Deputy Chief of Construction Division of the Special Projects Branch at Air Staff, was instrumental in the success of the project. Crockett appeared before Congress to request funding for the DEW Line. He calculated project cost estimates based on the use of metal pre-fabricated

Engineering Research in the Arctic

The Army and the Army Air Forces had undertaken research in the Arctic since before World War II. Aviation engineers building wartime airfields in Alaska and Army engineers building the Alaska Highway confronted problems associated with permafrost, or perennially frozen ground. In the late 1940s and early 1950s, renowned soils engineer Karl Terzaghi worked on the physics of permafrost to support the construction of airfield foundations in Alaska. By the early 1950s, the Air Force also benefited from the work of the U.S. Army Corps of Engineers Research Area near Fairbanks, Alaska, which conducted intensive studies of the structure of permafrost and had developed designs for airfield runways, buildings, and facilities in that delicate environment. The engineers worked with the knowledge that the Russians had been conducting organized research on permafrost for 15 years, particularly in Siberia where they experienced failures along the Trans-Siberian Railroad. Not all permafrost was created equal and it varied considerably depending on the type of soil that was frozen.[135]

structures. According to Crockett, "At one point we had all the aluminum factories in the United States tied up with just that one project. We tied up the aluminum industry for quite a while."[136]

In February 1955, the job of selecting sites and constructing the main stations of the DEW Line was under way. The DEW Line project was divided into three sections: an Alaskan section, a western Canada section, and an eastern Canada section. Site selection was difficult, due to the arctic dark and limited topographic data. The 3,000-mile route passed through a variety of terrains from the flat tundra of the arctic slope in Alaska and western Canada, to rugged mountains on Baffin Island. Engineers used available aerial photographs, but photo coverage was limited. Many maps were inaccurate or incomplete. Extensive aerial reconnaissance was conducted over a number of alternative routes to select suitable sites. Each area then was surveyed for landing strips, building locations, and to identify sources for gravel used in construction. Ground crews were flown into the area using ski planes and made final site selections. Site data were used to generate site plans for construction purposes.[137]

Construction began on approximately one-third of the stations by June 1955. Three types of stations were built: small, unmanned "gap filler" sites that were checked by aircrews every few months during the summer; intermediate stations manned by a chief, a mechanic, and a chef; and, larger stations manned by a variable number of operators and employees. Each main DEW Line facility comprised a main building to house equipment, power plants, and living accommodations for personnel. A garage housed motor vehicle equipment. The remainder of the site was devoted to towers for the antennas, fuel storage systems, roadways, the airstrip, and, at selected locations, hangars to protect supplies and maintain aircraft.[138] David Neufeld, Yukon and Western Arctic Historian for Parks Canada, documented one typical station of the system:

Construction at a Distant Early Warning site.

> The station consists of a main building including residences, mess hall, radar, workshops, and power generators. A large warehouse and a fully equipped garage supported the station's activities. These buildings, a network of connecting roads, a year's supply of fuel oil and diesel, and an airstrip are built on a three-meter-thick pad of gravel floating on top of the permafrost. The station is visually dominated by the various radar and communication antennae surrounding it.[139]

One innovation in building the radar sites was the use of modular, prefabricated building units. Main buildings were erected by assembling a number of modular units end to end in train-like fashion. Each modular unit was made of factory-built pre-insulated panels designed for easy assembly and to withstand arctic ice, snow, and wind conditions and to conserve heat. The modular sections were shipped to the site, and assembled to meet the design requirements of the station. Gap filler sites used 5 modular buildings, intermediate stations had 25, and main stations required 50.[140]

The Bureau of Standards conducted extensive tests on the buildings used for the DEW Line, including fire tests, vapor barrier tests, and decomposition value tests for 30 combinations of surface materials. The structures also underwent climatic and structural tests under the supervision of engineers at Eglin AFB, Florida.[141] Testing on acceptable pre-fabricated alternatives for replacement structures for the DEW Line continued throughout the 1950s.

Construction of the main portion of the DEW Line from Cape Lisburne to Cape Dyer was completed by July 1957. A total of $297 million was expended in construction. The Air Force took beneficial occupancy at 40 DEW Line stations between July and December 1956; 20 stations were accepted by May 15, 1957. The system was operated under a modified industrial-type contract by AMC until the completion of facilities, then turned over for operation to ADC. Transfer of operational facilities of the DEW Line was complete by May 1958.[142]

The arctic January hits a Distant Early Warning line construction camp.

The Pinetree and DEW Lines were integrated into the Semi-automatic Ground Environment (SAGE) system through a system of relay stations. SAGE was an automated system for the collection, dissemination, and display of radar data that was developed concurrent with the DEW Line for an estimated total construction cost of $300 million. The entire United States eventually was covered by the system. The Air Force awarded a comprehensive contract to the Western Electric Company for the design and construction of the SAGE sites. A Joint Project Office was established to monitor the DEW Line and SAGE projects, with representation from all interested commands. The North Atlantic Region AFIR office served as the AFIR for both projects. Construction at the first two SAGE sites began in late 1954, and the system was declared operational on June 26, 1958, when the New York sector came on line. Air Force enthusiasm for SAGE led to the planning of an intricate network of eight air defense regions within the CONUS and 32 SAGE direction centers. Information from the various radar networks fed into the headquarters for the North American Air Defense Command (NORAD) at Ent AFB, Colorado, where command of the air defense network was linked to 54 fighter-interceptor squadrons backed up by 66 Nike-Ajax missile battalions.[143]

DYE Stations

As the DEW Line neared completion in May 1957, the DoD decided to extend the project east from Baffin Island across the Davis Strait to Greenland and then on to Iceland. Despite the knowledge gained through past work in the far northern reaches of North America, construction on Greenland's polar icecap was accompanied by a new set of challenges.[144]

The eastern extension included five stations: DYE-1 on the west coast of Greenland near Sondrestrom AB, DYE-2 and DYE-3 on the icecap, DYE-4 located 35 miles off the east coast of Greenland at the southern tip of Kulusuk Island, and DYE-5 on the southern coast of Iceland near the U.S. Navy base at Keflavik. Engineers contended with arctic conditions and high elevations. DYE 1 was sited at an elevation of approximately 4,800 feet, DYE 2 and DYE 3 at 7,600 and 8,600 feet respectively, and DYE 4 at an elevation of only 1,100 feet, but on the rugged east coast where the shipping season began and ended in the month of August.[145]

Design of the two coastal stations began in early 1957. At the same time, a feasibility study was conducted to inform decisions on construction on the icecap. The top 60 feet of the icecap comprised compressed snow with a dry, crust surface. Beneath the snow was solid ice extending to an estimated depth of two miles at the center. The rim of the icecap rose sharply, was deeply crevassed, and dangerous to traverse.[146] In the interest of increased efficiency, engineers developed designs for two-story buildings for the stations. The building measured 107 x 176 feet and consolidated station functions in a single structure. A radome was mounted on a seven-story central tower to enclose the four tropospheric reflector antennas. A separate survival building was located at a safe distance from the main station to serve as a personnel shelter in the event of emergency. Construction oversight was handled by the East Ocean Division of the U.S. Army Corps of Engineers, whose jurisdiction extended from British Columbia to the Azores and from the North Pole to Bermuda.[147]

All labor and materials for the construction in Greenland were imported from the United States and Europe. Tilt-up construction techniques were employed, similar to those used previously for the construction of warehouses at Goose Bay Air Base in Canada, to reduce construction time to a minimum. Aluminum-clad plywood wood-frame panels, known as Clement panels, were assembled in the field. An exhaustive search for suitable prefabricated buildings eventually identified the Schokbeton, a modular, reinforced concrete panel-and-frame structure. Panels, beams, girders, and truss members for station buildings were cast in modular molds using pre-stressed high-strength, reinforced concrete in a factory in Holland and then shipped to the DYE sites accompanied by erection equipment and crews.[148]

Engineers also addressed unique climatic and site conditions during the project. Snow accumulation, which averaged three to four feet per year on the icecap, presented a particular design challenge.

Wind tunnel tests revealed that structures elevated on stilts allowed snow to pass underneath the buildings, thus minimizing structural damage from drafting snow. As a result, the main DYE buildings were elevated structures that were raised annually to accommodate the rising surface level of the ice pack and to compensate for settlement in the structures.[149]

The main structures at each installation were supported on massive columns along each elevation designed to extend 30 feet below the icecap surface. The columns rose approximately 90 feet above the surface of the ice. Lateral movement was controlled by interconnecting steel trusses. Each pair of columns enclosed two 350-ton jacks. The building load was transferred to the jacks and "floated" to correct differential settlement and to raise the structure, as necessary, above the snow. Prefabricated column extensions made raising a building possible to a height of 30 feet, or a level sufficient to accommodate 10 years of anticipated icecap build-up.[150]

Each site also was equipped with four 100,000-gallon storage tanks for fuel oil. These tanks were installed in the icecap and designed to withstand the pressure associated with 15 to 10 years of snow accumulation. Fuel was delivered to the sites by air in collapsible rubber storage tanks. The icecap, itself, was the source of potable water. Snow harvesters, consisting of cables and drag-line buckets, operated from inside the buildings. The snow was dumped into hoppers and fed into snow melters. Electric power at the sites was provided by 150 kW diesel generators. Nine generators were employed at DYE 4 and six at each of the other sites.[151]

Construction of the two coastal DYE stations began in 1958, and work on the icecap stations was underway in 1959. Fixed fee contracts were awarded to Danish Arctic Contractors for construction of the coastal DYE stations and to Peter Kewit & Sons for the icecap stations. Contract provisions specified that construction equipment used in Greenland was to be provided by the government, while local labor and materials obtained by the contractor were to be used in Iceland. Roads, airstrips, helipads, and beaching areas were constructed during summer 1958; construction equipment and material were purchased to initiate station construction in 1959. Contract personnel arrived on-site in early July 1958 and worked until mid-November.[152]

Construction work resumed in early April 1959 with foundation excavations. The short construction season necessitated an intense work schedule—two 10-hour shifts a day, seven days a week. All outside construction work was completed on schedule by October 1. The stations were 63 percent complete by that date. Interior work continued throughout the winter months. During the 1959 construction season, about 13,000 tons of materials were airlifted from Sondrestrom to the icecap sites. The contractor was responsible for maintaining the snow runways.[153]

All five DYE stations were completed during the 1960 construction season. Following the installation of antennas and operating equipment, the complexes were turned over to the Air Force on December 30, 1960.[154]

Texas Towers

Despite excellent radar coverage to monitor air traffic from the north, the United States still lacked radar coverage to ensure adequate warning of air traffic approaching from the east. Sea-based radar platforms located 100 miles off the coast of New England provided a solution. These stations were known commonly as the Texas Towers, because their designs resembled oil-drilling rigs used in the Gulf of Mexico.

The Air Force proposed the construction of five off-shore platforms; three were built. They were designed by the U.S. Navy Bureau of Yards and Docks, which also acted as the construction agent. The New England Region AFIR monitored the project. The contract for the Texas Towers was awarded to Raymond-Delong, a joint venture with extensive prior experience in erecting docks and oil drilling platforms using equipment known as the Delong Air Jack.[155]

The selected sites were located along the continental shelf where the elevation of the ocean floor was shallow enough to permit construction of the platforms and far enough at sea to be strategically important. In contrast to the medium-range radar sets used aboard Navy picket vessels, the fixed installations made possible the installation of heavy duty, long-range radars identical to those used at land sites. In conjunction with the other AC&W sites, the Texas Towers extended contiguous east coast radar coverage approximately 300 to 500 miles seaward, affording at least 30 extra minutes of warning time of an inbound enemy bomber attack.[156]

Lincoln Laboratory had recommended the installation of five Texas Towers and identified the sites best suited for positioning the radars:

TT-1	Cashes Ledge
TT-2	Georges Shoal
TT-3	Nantucket Shoal
TT-4	Unnamed Shoal
TT-5	Brown's Bank

In autumn 1953, the Secretary of the Air Force, on ADC's recommendation, authorized construction of all five. Funds were budgeted in fiscal years 1954 and 1955. The Bureau of Yards and Docks was vested with the authority to conduct ocean surveys, execute design engineering, develop specifications, and perform other services requisite to issuing a construction contract.[157]

Each platform comprised three decks, configured as equilateral triangles. The sides of the decks measured 210 feet providing an overall surface area of approximately one-half acre. The top deck was fitted with three pressurized radomes and a 23 x 60-foot deckhouse, which housed the radar operation and equipment rooms. The second deck contained quarters for 54 Air Force personnel, a large mess hall and recreation room, and two engine rooms for the four 100 kW diesel generators. The lower deck was elevated 63 feet above sea level and out of reach of the highest anticipated storm seas. This level housed operating equipment, such as pumps, boilers, evaporators, and storage tanks for fresh water and fuel oil.[158]

The superstructure of the first Texas Tower (TT-2) was completed by the Bethlehem Steel Company at its Quincy, Massachusetts, facility and was launched on May 20, 1955. The superstructure was towed by Raymond-DeLong to the platform site on the Georges Shoal, 110 miles east of Cape Cod with a depth of 56 feet of water. The first stage of the installation involved sinking three permanent steel caissons 48 feet below the ocean floor. Once the caissons were sunk to grade by jetting and excavating, the outer shells and the inner caissons were filled with concrete to a depth of 40 feet. A steel tube measuring six feet in diameter was then anchored inside each 10-foot diameter caisson and the concrete was placed between the two tubes. The inner circular well of the caissons housed utilities, such as salt-water intakes, sanitary discharges, and connections for supplying fuel oil and fresh water from tankers. The steel supports extended approximately 140 feet to support the main deck level.[159]

Despite hurricane-force winds and high seas during the erection of TT-2, the platform performed successfully and met design expectations. The Air Force assumed beneficial occupancy and the site began operation in December 1955. By that date, off-shore radar coverage was anticipated to be expanded by coastal AC&W squadrons in the vicinity of Cashes Ledge and Brown's Bank, leading the Secretary of the Air Force to cancel the fabrication and installation of the TT-1 and TT-5.[160]

By November 1955, bids for the next two towers, TT-3 and TT-4, had been accepted. Construction contracts for both platforms were awarded to J. Rich Steers, Inc., in collaboration with Morrison-Knudsen, Inc. The platform and legs for TT-3 were launched for installation in August and towed to Nantucket Shoal. ADC assumed beneficial occupancy in November 1956. The TT-4 platform was constructed at South Portland, Maine, and towed to sea and placed at Unnamed Shoal in June 1957. ADC assumed occupancy in November of that year. Eventually, all three towers were converted from manual operation to SAGE control.[161]

One of the Texas Tower sites under construction.

On January 15, 1961, in the wake of a severe winter storm, 28 members of a caretaker crew aboard TT-4 were killed when the tower collapsed to the ocean floor. This tragedy sealed the fate of the two remaining Texas Towers. Both towers were phased out as more sophisticated systems were installed aboard airborne early warning aircraft, thus eliminating the need to assume the risk and expense of operating the towers. In January 1963, the Joint Chiefs of Staff authorized inactivation of the Texas Towers, and ADC ordered them dismantled. TT-2 was decommissioned in January 1963 and TT-3 was decommissioned in March.[162]

Ballistic Missile Early Warning System (BMEWS)

While highly sophisticated in detecting aircraft, the DEW Line was not designed to detect incoming missiles. Following the Russian launch of Sputnik in October 1957, this shortcoming became a major concern. The experience gained in building the DEW Line was invaluable during the construction of the Ballistic Missile Early Warning System (BMEWS), which began in 1958 and was completed in 1963. The three detection sites in the system were located at Clear Air Station in Alaska, Thule AB in Greenland, and RAF Fylingdales in England. These three sites were able to detect a missile 3,000 miles away and track it from a distance of over 1,000 miles. The infrastructure of the earlier radar detection systems helped provide coverage. The rearward communication system for BMEWS involved a sub-marine cable extending from Thule to Cape Dyer, with communication links from Cape Dyer to Melville and Newfoundland. The communication links from Clear Air Station in Alaska extended to Pedro Dome and Tok Junction, and from Boswell Bay to Annette Island. ADC was the design and construction agent for all rearward communication sites with the exception of Cape Dyer.[163]

Congress approved $1 billion for the construction of BMEWS in late 1957 and construction funds for the first warning station near Thule AB were issued to the U.S. Army Corps of Engineers in February 1958; construction began in June. The U.S. Army Corps of Engineers served as the design and construction agent, using criteria furnished by the Radio Corporation of America (RCA), the systems engineer. An Air Materiel Command project office in New York City was charged with implementing the entire system. Design and construction activities were under the supervision of the North Atlantic Region AFIR and the Alaskan Air Command.[164]

Both the design and construction aspects of BMEWS were pioneering efforts. The system featured four billboard-type detection radars, each larger than a football field turned on edge and weighing more than 1,000 tons. The scale and weight of the BMEWS equipment required advanced construction techniques. Building on permafrost required that the foundations be maintained in a frozen state using mechanical refrigeration. The structural stability of the scanner buildings was critical. Safeguards were implemented to avoid sinking or settlement due to melting of the permafrost. The massive radar screens were designed to withstand winds up to 185 miles per hour.[165]

The Alaska and Greenland BMEWS stations were completed ahead of schedule and became operational in 1961. The station in England was not completed until 1963. In addition to the major construction at the three detection sites, limited construction to support communications for the system was undertaken at 26 locations in Alaska and Canada.[166]

Hot air inside an air-supported tent protects construction workers from falling temperatures at a base of the Ballistic Missile Early Warning System.

Into the Missile Age

The development and fielding of missile systems during the 1950s was driven by international politics and the urgency underlying national security policy during the Cold War. Defensive systems, such as the Air Force's BOMARC and the Army's Nike and Nike Hercules, were linked to early warning systems designed to intercept U.S.S.R. heavy bombers en route to the United States over the polar cap. The goals of offensive ballistic missiles, such as the Thor, Atlas, and Titan, were to strengthen the nation's military posture and to serve as deterrents to adversaries considering attack.

Rapid change in military technology as the United States entered the nuclear age marked this period of excitement tempered by concern over domestic security. In this climate, Air Force civil engineers were afforded new opportunities to support the Air Force mission. Through the design and construction of facilities for emerging missile systems, Air Force civil engineers participated closely in the development of each weapon system. To do so, Air Force civil engineers advanced their education to master the engineering intricacies of missile technology. Many attended schools offered by the missile manufacturers—Boeing, Convair, and Douglas. Some returned to college to study aligned fields, such as advanced soil mechanics. All learned on the job and gained invaluable experience. The missile field was a challenging assignment that broadened skill sets significantly. The opportunities influenced the direction of many Air Force officers' careers. Most officers associated with the program proudly wore the Missileer badge on their uniforms.[167]

Missile development for the Air Force was managed by the Western Development Division (WDD) of Air Research and Development Command (ARDC), located in Inglewood, California. Gen. Bernard Schriever became the first commanding officer of the organization in August 1954. He was given complete control and authority over all aspects of the Air Force missile program. His unprecedented and extraordinary powers included the authority to bypass Headquarters ARDC and communicate directly with other Air Force major commands, the Air Staff, and the Secretary of the Air Force. He was also given latitude to hand-pick the engineering officers who managed facility design and construction for the missile programs under his command.[168]

In 1956, General Schriever selected Col. (later Brig. Gen.) William E. Leonhard as his assistant for installations following his astute questions during a Pentagon briefing. When approached by General Schriever, Colonel Leonhard was working at the Pentagon as chief of the construction division and as deputy director of construction. In April 1958, Colonel Leonhard became the Deputy Commander, Installations, and was later named Deputy Commander, Civil Engineering and Assistant for Site Activation. Colonel Leonhard organized the civil engineering staff to mirror the missile development organization, with a senior officer in charge of construction for each individual missile system.[169] General Leonhard summarized his responsibilities at WDD between 1956 and 1961:

> I was the senior engineer [Assistant for Installations]. Not for the missile but for the facilities – the test stands, the launch pads, all of that stuff…I had budget responsibility for all funds that we got from the Congress for engineering services and for construction. That was my job, to get the money, and I made all the presentations to congressional committees, and the House and Senate Armed Services Committee, and the House and Senate Appropriations Committee. I got to know all of those people extremely well.
>
> Then I had responsibility for all the engineering and design work for the test facilities at Cape Canaveral, Florida, and test facilities out at Vandenberg Air Force Base on the West Coast. It was my job to get the money for the design work and to get the money for the construction.

> When I got into the deployment of an operational force, I was responsible for planning, selecting, and constructing deployment sites for the Atlas, Titan, and Minuteman ICBMs. I was not very involved in the selection of the parent Air Force Base or anything like that, but in situating the launch sites and so forth. That was my job—acquiring the real estate for every one of these. And remember, we had a thousand minuteman sites and 50 to 100 Atlas and Titan sites.
>
> The site construction process was complicated by the fact that the missiles' specifications seemed to change weekly. Atlas, for example, was a stage and a half, burning kerosene and liquid oxygen. Titan had two full stages and burned a hypergolic mixture of two fuels that burst into flame when they came in contact with each other. The Minuteman had solid fuel. A launch platform designed for one missile could not be used by another.
>
> Then the construction contracts were placed by—most of them were placed by the [U.S. Army] Corps of Engineers in the various districts where the work was to be done, and I would transfer money then to that district for the construction. I kept the engineering. All the engineering work was done out of my office. We had to place contracts with engineering firms throughout the country for engineering services, but that was done directly out of our office.
>
> When I would sit down with the district engineer in whose area we were going to build facilities—launch facilities, I said, "Our schedule calls for us to move in and occupy this site, and have it online by June of next year," whatever the date was. And if they said, "No, we can't do that because that's too quick, we need another three years for construction," I said, "You're not going to do the construction." And in those cases, I handled—placed the construction contracts myself.[170]

General Leonhard remained active in oversight during the construction of launch facilities. According to General Leonhard, the majority of personnel working in WDD were civil engineers:

> the organization was structured such that one group looked after the Atlas facilities, another group looked after Titan facilities, another group looked after Minuteman, and another group looked after Thor. At the height of the WDD program, I had 100 people working directly for me. My domain included design, engineering, and budget responsibility for all ground facilities.[171]

In 1954, the original WDD staff numbered 12 officers and 3 enlisted personnel. In just over a year, by December 1955, the staff had grown to 166 people. In the next three years, the missile program grew exponentially. In June 1957, the WDD was redesignated as the Air Force Ballistic Missile Division (AFBMD). By early 1959, AFBMD had a military and civilian staff of 1,200. The job of the civil engineers assigned to the organization was to work closely with the aeronautical engineers developing each missile type to design the ground support facilities that each system required. Once designs were completed and approved, the Air Force turned them over to the U.S. Army Corps of Engineers to contract for the actual construction.[172]

Each missile program required unique ground support facilities. In addition, successive generations of missiles developed under a program also required different ground support facilities. The following narrative summarizes major elements of the programs.

BOMARC

During the first half of the 1950s, national security concerns focused on the potential threat from manned bombers from the U.S.S.R. rather than the threat posed by long-range missiles. As a result, early emphasis was placed on developing anti-aircraft missiles. The Air Force's long-range anti-aircraft missile was the BOMARC, a joint U.S.-Canadian effort named for the two organizations that supported the development of the missile, Boeing and the Michigan Aeronautical Research Center. Design of the missile began in 1946 and it was ordered into production in 1955.[173]

Testing and training for the BOMARC was conducted at Eglin AFB, Florida. Missile tests were undertaken using the Eglin Test Range over the Gulf of Mexico due to the prohibition on firing missiles at operational bases except in the event of enemy attack. The first test flight of a BOMARC occurred in February 1955. The following spring, the Air Force issued instructions to construct an Operational Suitability Test and Training Facility for the BOMARC program on Santa Rosa Island at Eglin AFB. Lessons learned during the design and construction of the Santa Rosa facilities were incorporated into design for the first tactical BOMARC base. Three different architect-engineer firms adapted the Eglin AFB plans for use in the construction of the first three BOMARC bases. The U.S. Army Corps of Engineers developed standard plans for subsequent site adaptation based on Air Force criteria.[174]

The BOMARC program pioneered several firsts in relation to support facilities. It was the first large-scale missile program that was critically dependent on complex support facilities procured through the MCP. It also marked the first time that the Air Force, the U.S. Army Corps of Engineers, and a weapon system contractor worked collaboratively to execute a complex missile program. As the first such large-scale program, BOMARC addressed a number of compatibility issues between the missile and the launch facilities that foreshadowed challenges encountered during the Atlas and Titan intercontinental ballistic missile (ICBM) programs. The development of a process to resolve such issues was one of the valuable contributions of the BOMARC program.[175]

In early 1958, the Air Staff approved the establishment of 10 BOMARC units, and site surveys were completed to identify the appropriate locations. The first four BOMARC complexes were sited at Dow AFB, Maine; Suffolk County AFB, New York; McGuire AFB, New Jersey; and Otis AFB, Massachusetts. Eight BOMARC squadrons eventually were deployed along the eastern seaboard and in the Midwest. The additional four complexes were sited at Niagara Falls, New York; Kincheloe AFB, Michigan; Duluth AFB, Minnesota; and Langley AFB, Virginia.[176]

Model "A" of the BOMARC used a liquid-propellant rocket, while the more advanced "B" model employed a solid-propellant booster rocket. All BOMARC sites included a missile launch area, an air munitions building, and one or two buildings to house gas compressors. Model A sites contained a chilled-water generating and distribution system, a propellant acid facility for storing and dispensing inhibited red fuming nitric acid (IRFNA), a propellant fuel facility for storing and dispensing JP-X and 80-octane gasoline and Aniline Furfuryl Alcohol (ANFA), and a decontamination facility for purging liquids from the missile. The transition to the solid-fueled rocket eliminated the need for liquid fuel facilities. These facilities were extremely troublesome in the "A" program and required high-pressure helium, which was expensive and had to be tightly controlled to minimize losses.[177]

The shelters designed to house both models of the missile were similar in size and featured a distinctive roof design incorporating two cantilevered planes that were controlled by a hydraulically-driven rolling system to open and to close the roof during launchings. The Model A shelter was marked by massive, reinforced-concrete longitudinal walls that supported the rolling roof and were designed to resist acceleration and deceleration forces. Model A shelters included tight weather seals on the end doors and roof to support an interior controlled environment. In the Model B shelter, steel frames, precast-panel walls, and other improved design features, including the elimination of environmental controls, were introduced to reduce costs.[178]

The complex, automated launch system for the BOMARC comprised sensitive controls that were easily fouled by contaminants in gas or hydraulic systems. Stringent cleaning protocols for the piping system were imposed that exceeded those normally employed in the construction industry. After initial cleaning, the clean piping system was maintained until all components were connected to form the complete subsystem. Gas piping was maintained through positive pressure with nitrogen; hydraulic piping was filled with hydraulic fluid.[179]

The first BOMARC operational base was completed at Dow AFB, Maine, in late 1959. The general contractor on the $9 million, 56-missile project was the John A. Volpe Construction Company. The missile area containing the launch shelters and shops was supported by a separate area for utilities, security, and storage. A new element, the utilidor, was installed beneath the missile area and comprised a series of reinforced concrete tunnels that housed the network of wires, pipes, and tubing that supported the missile system.[180] Despite challenges, all BOMARC "A" sites were operational on schedule. In 1959, the Air Force's new air defense master plan reduced the number of BOMARC operational bases from 32 to 16. Each base was armed with 60 missiles.[181]

This first large-scale missile program was a milestone for Air Force civil engineers and their involvement in the weapon system acquisition process. Several key lessons were derived from the experience that informed the development of future programs. First, early participation by Air Force civil engineers in the weapon system program was critical to assure timely consideration of fully supporting real property requirements. Second, aggressive participation by engineers in all phases of the weapon system program was desirable from development, to design, and through implementation. Third, indoctrination in the weapon system management concept and keen awareness of the unusual facility requirements were important to the success of Air Force civil engineer personnel. Finally, clear and effective communication between developers and civil engineers was necessary to ensure the appropriate development and prioritization of elements within support facilities.[182]

Intercontinental Ballistic Missile and Intermediate Range Missile Programs

Intelligence reports in the early 1950s indicated that the U.S.S.R. possessed not only atomic weapons, but also was developing ballistic missile capability. In 1953, Trevor Gardner became special assistant for research and development to the Secretary of the Air Force. He organized a "Strategic Missile Evaluation Committee," commonly known as the Teapot Committee, to review the Air Force's long-range missile program and to make recommendations for improvements. The committee's report, submitted to the Secretary of the Air Force in February 1954, identified technical and managerial problems related to the Atlas Intercontinental Ballistic Missile (ICBM) program. That report gave Gardner and General Schriever leverage to accelerate the program. In May 1954, Air Force Vice Chief of Staff Gen. Thomas D. White assigned Project Atlas as the highest Air Force priority.[183]

The results of an overall assessment of the nation's defenses were issued in the February 1955 Killian Report, which was compiled by the Technological Capabilities Panel of the Science Advisory Committee established by President Eisenhower. The Killian Report warned of the consequences of the U.S.S.R. achieving an operational ICBM force before the United States. The report urged the National Security Council (NSC) and the President to recognize the ICBM development program as a "nationally supported program of the highest order," with the goal of achieving a full-scale test of an ICBM by 1958. On September 8, 1955, President Eisenhower approved NSC Action No. 1433, which designated the ICBM program as the nation's highest R&D priority and directed the Secretary of Defense to prosecute the priority with maximum urgency. Three months later, on December 1, President Eisenhower assigned the highest national priority to the Thor intermediate range ballistic missile (IRBM), as well.[184]

Construction of Missile Testing Facilities

Testing facilities at Cape Canaveral, Florida, and Vandenberg AFB, California, were among the first elements constructed to support the missile programs. While selective missile testing had occurred at Cape Canaveral as early as 1950, the ballistic missile program led to rapid and extensive expansion of facilities there and at Vandenberg AFB. In later years, as the missile program grew in size and complexity, time was a priority in bringing new test facilities on line. As a result, the Air Force assumed responsibility for overseeing the design and construction at Cape Canaveral and Vandenberg AFB.[185]

Cape Canaveral had been under Air Force jurisdiction since 1948. In May 1949, President Truman authorized the establishment of a joint long-range proving ground at the site. In 1950, the Long Range Proving Ground Base was renamed Patrick AFB in memory of Maj. Gen. Mason Patrick. Cape Canaveral, about 20 miles north of Patrick AFB, became the Cape Canaveral Missile Test Annex, also known as Station No. 1 of the Atlantic Missile Range.[186] The Air Force sought Congressional approval to apply $44 million from a general authorization to urgent construction at Patrick AFB, Cape Canaveral, and downrange auxiliary bases in the Caribbean and South Atlantic, and to engine test facilities at Holloman AFB, New Mexico. The construction program at Cape Canaveral continued to grow, peaking at nearly $50 million a year in 1957 and 1958.[187]

The U.S. Army Corps of Engineers, Jacksonville District, was responsible initially for construction at Cape Canaveral and Patrick AFB. In 1950, the U.S. Army Corps of Engineers built the first concrete missile launch pad, which was used to test a World War II surplus V-2 rocket. Between 1950 and 1960, Cape Canaveral and Patrick AFB were transformed into a city of launch facilities, control centers, and assembly buildings serviced by miles of underground utilities.[188] To accommodate larger missiles with more powerful engines, civil engineers designed complex launch stands, which were supported by robust foundations. On such stands, missiles were housed on concrete and steel structures elevated approximately 30 feet above grade. Launch stands were built to withstand up to one million pounds of thrust; up to 13,000 feet of steel piling were used to anchor a single pad. Engineers designed static test towers at Cape Canaveral to enable the test firing of large missiles while secured firmly in place. All of these new facilities required the development of detailed specifications for construction, as well as maintenance.[189] By 1960, approximately 20 launch complexes were constructed at Cape Canaveral. These facilities were used to launch almost every type of missile in the Army, Navy, and Air Force inventories.

The IRBM and ICBM programs also necessitated reactivation of several Caribbean installations to support the downrange missile program. These installations were inactive since the end of World War II, but retained by the United States under a 99-year lease agreement with the United Kingdom. Several bases were transferred from Caribbean Air Command to ARDC for facility upgrades. Potable water was a challenge in the islands. ARDC used P313 Military Construction design funds to investigate the best methods of providing permanent fresh water to all off-shore stations with help from the U.S. Geological Survey. In 1954, the U.S. Navy began construction on 5 of the 12 off-shore auxiliary bases in the Caribbean and the South Atlantic.[190]

As IRBM and ICBM development accelerated, the Air Force sought a location for testing missiles under operational conditions. A nationwide search of 100 potential locations concluded in 1956 with the selection of Camp Cooke, later renamed Vandenberg AFB, California. Located on the Pacific Coast about 120 miles northwest of Los Angeles, the 65,000-acre site afforded favorable weather for launch operations year-round in an area that was relatively remote, yet within commuting range of southern California's aerospace industry.[191]

In early 1957 a small contingent of civil engineers lead by Lt. Col. Fred Smith literally reopened the gate at Camp Cooke to begin master planning, design and construction of infrastructure, support and very soon operational missile complexes. Lt. Col. Smith reported directly to then-Colonel Bill Leonhard at AFBMD in Inglewood, California. At the time, Camp Cooke consisted of hundreds of

World War II mothballed, temporary mobilization buildings. Many of the existing buildings were moved, connected, and renovated to meet the new architectural program as expediently as possible. Groundbreaking for the first new facilities took place in May 1957. Construction was managed through the cooperative efforts of the U.S. Army Corps of Engineers, San Francisco District, the AFIR office in San Francisco, and the WDD (later AFBMD).[192]

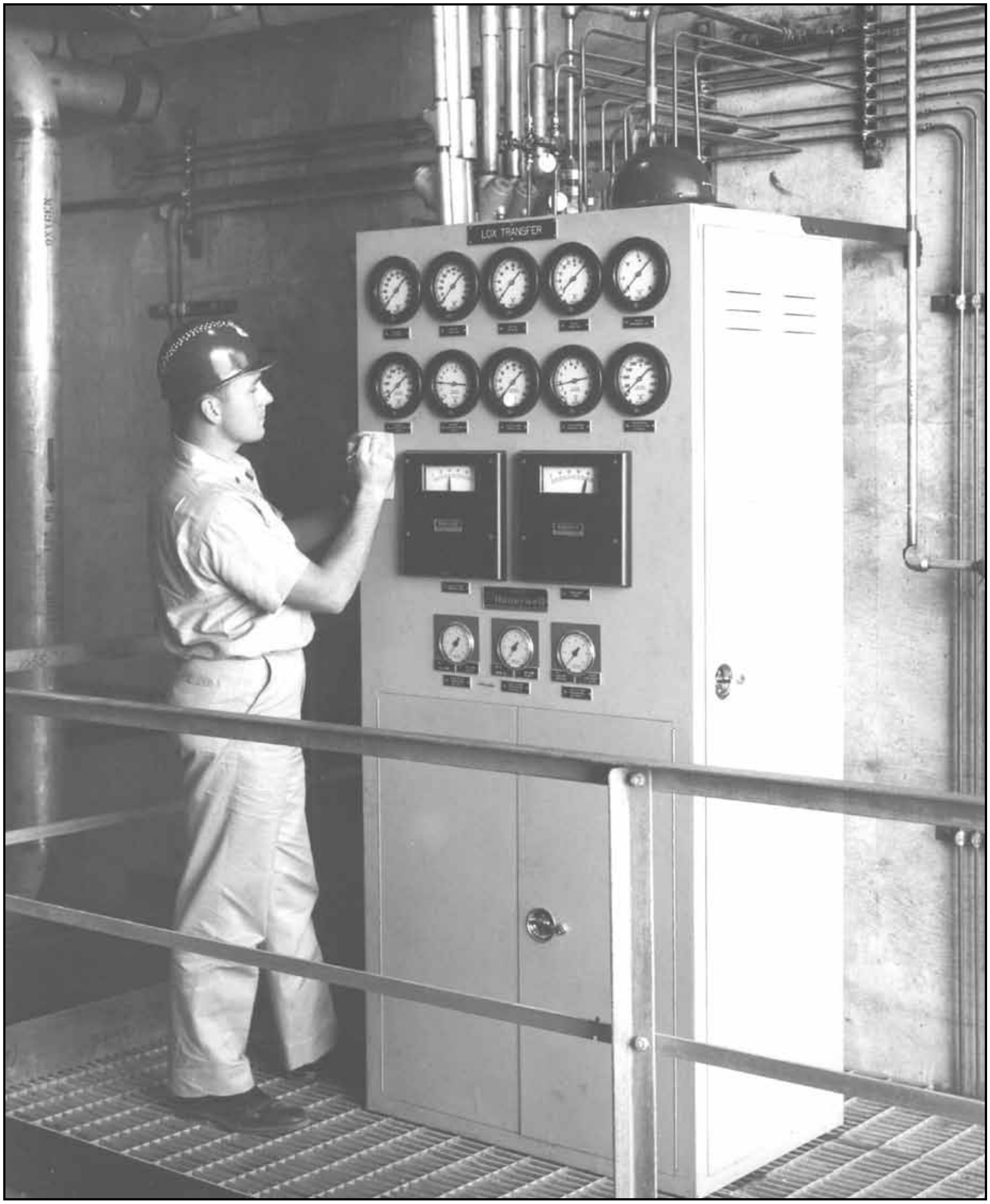
With the help of Holmes & Narver, a Los Angeles architect-engineer firm, the civil engineers at Cooke reconfigured the existing building stock into a headquarters complex for the 1st Missile Wing, operational and training facilities, a community center, a base exchange and commissary, a motor vehicle maintenance complex, and other facilities. This effort, combined with the construction of the Thor, Atlas, and Titan launch facilities during 1957 and 1958, rendered the base one big construction site.[193] Over the next three years, the Air Force expended over $200 million on new construction and upgrades to existing support facilities. The project was a monumental effort.[194] Two young lieutenants, Clifton D. "Duke" Wright and Joseph A. "Bud" Ahearn, were among the first civil engineer officers to be assigned to Camp Cooke in 1957 and 1958. Later in their careers, they both became two-star general officers and leaders of Air Force Civil Engineering.[195]

The intense construction program led to repeated discussions between civil engineers and missile developers regarding the classification of real property installed equipment (RPIE) and systems-related equipment, owing to the close integration of weapon systems and the buildings. Such classifications defined operations and maintenance responsibilities for equipment and had implications on future budgets. The integrated system associated with the weapons projects at Vandenberg AFB were the first to be operated and maintained by the base installations engineer. This responsibility typically fell to an aircraft maintenance squadron.[196]

Many facilities at Vandenberg were sited in the dunes close to the Pacific Ocean. These landforms presented technical challenges in construction. Initial surveys documented that the contours of the dunes shifted as much as 20 feet per week during strong winds. General Leonhard identified stabilization of the sand dunes as an objective and assigned the project to a young Air Force engineer named Capt. (later Brig. Gen.) John Peters, who developed a solution to the shifting dunes using sustainable vegetation. Working with a colleague who was employed at an oil company, Captain Peters assembled a team that built a small wind tunnel using an old tank sweeper, a pitot tube, and an old airspeed indicator from the junkyard. Through trial and error, it developed a process for spraying a mixture of

Lt. Clifton D. "Duke" Wright, Jr. in front of his first home at then-Cooke AFB. One of his first assignments was as the on-site project officer for the first Atlas ICBM training and launch complex. (Courtesy of Maj. Gen. Wright) water, sticky resin emulsion, liquid fertilizer, and grass seed onto the salt-rich sand. The grass cover stabilized the dunes and the thorny problem of the "Galloping Sand Dunes" was solved.[197]

Seven launch pads and three blockhouses for Thor IRBM testing were the first facilities completed at Vandenberg. The first Thor was launched on December 16, 1958. Prototype launch pads, control facilities, and silos for every generation of ICBM eventually were built and tested at Vandenberg



Lt. Joseph A. "Bud" Ahearn performs system testing at the Atlas missile launch complex at Vandenberg AFB, California, 1958. (Courtesy of Maj. Gen. Ahearn)

AFB. By the late 1950s, attention was focused on the construction of the Atlas and Titan complexes. Complex 576A at Vandenberg was outfitted with three above-ground gantries for the Model D, while Complex 576B included three above-ground coffin launchers. Each complex had its own launch control center. The first Atlas launcher was completed by the contractor and accepted by the Air Force in October 1958; the first Atlas D missile arrived on base in February 1959. The Atlas D first was fired from Vandenberg on September 9, 1959.[198]

Missile development required extensive testing of rocket engines. In the late 1950s, civil engineers oversaw the construction of massive engine test facilities in the Mojave Desert at Edwards AFB, California. The first static test stand for handling rocket engines with up to one million pounds of thrust was completed at a cost of $10.1 million. The 200-foot-long test stand was similar to a reinforced concrete bridge in design and protruded 150 feet above the flame deflector pit. The test stand included a 54-foot concrete cantilever anchored some 60 feet into solid rock. A multi-story instrumentation and control building was connected to the test stand by a 300-foot underground tunnel.[199]

Thor

The 1955 Killian Committee had recommended the development of a class of intermediate range ballistic missiles with a 1,500-mile range as a stop-gap defense measure until the ICBM program was operational. In December 1955, the Air Force awarded the contract to develop this type of missile, named Thor, to the Douglas Aircraft Company.[200]

After undergoing missile testing at Cape Canaveral and operational testing at Vandenberg AFB, Thor entered the active inventory in September 1958 and was deployed to four bases in England. The commander of SAC's 7th Air Division at Royal Air Force (RAF) South Ruislip near London was designated as the executive agent for the Thor site activation program in England. Civil engineers assigned to 7th Air Division worked intensively with representatives from the British Air Ministry Works Directorate and with engineers from Third Air Force, who were responsible for the design and construction of Thor facilities.[201]

Four RAF installations were selected as sites for the Thor: Feltwell, Shepherds' Grove, Tuddenham, and Mepal. Sites were selected through strict application of stringent criteria. A sense of urgency was introduced by the short two-year schedule for construction and activation of the missiles. Sixty missiles were to be sent to the U.K. The RAF activated 20 missile squadrons; each squadron controlled three missiles. President Eisenhower and British Prime Minister Harold Macmillan reached accord in 1957 regarding the Thor missiles. Under the agreement, the rockets were the property of the British government and missile sites were manned by British troops. Warheads, however, remained under U.S. control. A dual key system allowed the RAF to initiate a countdown, but missile launch required that a U.S. Air Force officer arm the warhead.[202]

The 65-foot Thor had a single-stage liquid oxygen rocket motor that provided 150,000 pounds of thrust. It was launched from a combination transporter-erector vehicle, which required an absolutely level surface during operation. The amount of excavation and fill required at each missile site varied according to ground conditions and topography. Overall construction of the four complexes required the excavation of approximately 600,000 cubic yards of earth and the installation of 80,000 cubic yards of base concrete, 60,000 yards of vibrated concrete, and 90,000 cubic yards of high-quality concrete. Once the concrete was cured, the erection of a steel frame for the retractable missile shelter and installation of 18,000 feet of steel rails followed. All construction work was executed within very exacting tolerances.[203]

Electrical service to the launch pads included standby generating 200 KVA frequency changers, which converted U.K. electrical current to U.S. standards. An aircraft hangar at each base was renovated to house maintenance and technical facilities and included full air-conditioning and dust-proof floors. Electrical service to the hangars was provided by several sources as a safeguard against power outages. The hangars also were fitted with overhead cranes and high-pressure air and nitrogen systems.[204]

The first complex was completed in December 1958. The second and third complexes were finished in April and September 1959, and the fourth in January 1960. The first Thor missile arrived in England in September 1958 aboard a C-124 Globemaster. To prepare for their new mission, RAF missile squadrons completed training at the Douglas Aircraft Company school in Tucson, Arizona, and operational training at Vandenberg AFB. The first launch of a Thor missile by a RAF strategic missile squadron occurred at Vandenberg AFB on April 16, 1959.[205]

Deployment of the Thor IRBM was intended as an interim security measure. As the Atlas and Titan ICBMs entered the arsenal and were placed on operational alert in 1960, IRBMs gradually were withdrawn from service. The Thor missiles in England were removed from operational alert in August 1963 and the RAF Thor squadrons were disbanded. The program had achieved its objective as an interim security measure and provided in-field experience for a number of Air Force civil engineers who later made valuable contributions to the ICBM program.[206]

Atlas and Titan

In August 1957, the U.S.S.R. successfully tested the world's first ICBM, the SS-6, following the launch of the satellite Sputnik. These launches demonstrated that the U.S.S.R. possessed the rocket technology that made a nuclear strike on the United States possible. The United States was alarmed to learn that its own missile development program lagged behind that of the Soviet Union. As a result, a new "emergency" ICBM plan was approved by President Eisenhower and the NSC on January 30, 1958.[207]

The first U.S. ICBMs, the Atlas and the Titan I, were large, liquid-fueled missiles. The one-and-a-half stage Atlas and the two-stage Titan shared many interchangeable systems. One objective of the newly adopted plan was to broaden the knowledge base and stimulate competition to turn out a weapon in the shortest time possible. The Convair Division of General Dynamics held the contract to develop the Atlas, a missile with a military application that also advanced the manned space program. The contract to develop the Titan ICBM was awarded to Glenn L. Martin Company in late 1955, as a safeguard against failure of the Atlas. Titan ultimately became the Air Force's principal liquid fueled missile and remained on alert with SAC well into the 1980s.[208]

Brig. Gen. Bernard Schriever at AFBMD was authorized to implement an innovative policy, which he called concurrency, to expedite missile development. Under the policy, many aspects of the plan were conducted simultaneously—missile development, testing, production, crew training, and base construction. General Schriever described the new policy as "moving ahead with everything and everybody, altogether and all at once, toward a specific goal." Program developers compressed schedules from an estimated 13 years to 5 years. The typical sequence of designing ground facilities following the final missile design was abandoned; construction of ground facilities proceeded concurrently with missile development to meet the overall program deadline. Technology advanced with dazzling speed. Weapons systems often were obsolete and replaced by the next generation before support facilities were completed.[209]

Concurrent development expanded the challenges faced by Air Force civil engineers as plans, programs, and designs for site facilities proceeded on a parallel track with missile development so that launch and support facilities would be operational as soon as missiles came off the assembly line. Construction was initiated using untested, and sometimes incomplete, plans with the expectation that construction documents would be revised and refined as development of the missiles progressed. Construction on several Atlas and Titan bases preceded the first full test firing of either missile.

The cost of concurrent development was unavoidably high. Change orders mounted rapidly and were a source of concern and frustration for Air Force civil engineers and contractors alike. During construction of the Atlas base at F.E. Warren, for example, 70 design changes were issued in the 30 days between the issuance of initial construction plans to prospective bidders and the opening date for proposals. As construction advanced, change orders often required alterations to completed work.[210]

Under the Atlas program, technological advances and improvements led to the production of several successive generations of weapons. The A, B, and C missile models and initial development and test vehicles, were followed by three operational missiles, the D, E, and F models, each with its own specialized launch and control facilities. Atlas D missiles were stored horizontally above ground in containers called "coffins" that provided blast protection against overpressures of only 5 psi. They had to be raised upright to load fuel and liquid oxygen prior to launch. The Atlas E was also deployed horizontally, but the majority of the semi-hardened launcher was buried underground. The coffins were of heavier construction and had concrete overhead doors that were flush with the surface. They were designed to withstand overpressures of 25 psi.[211]

The Atlas F was stored vertically in underground silos measuring 174 feet deep and 55 feet in diameter. Built of heavily-reinforced concrete, the huge silos protected the missiles from overpressures of up to 100 psi. The Atlas F had fuel stored on board the missile. It was loaded with liquid oxygen at the beginning of the countdown and raised to ground level by elevator for launch. The hardened silos increased survivability, but also raised the complexity of construction. Approximately 2.7 million cubic yards of earth were moved. Construction materials included almost 100,000 tons of steel and 565,000 cubic yards of concrete. Site excavations to the depth of 60 feet were required to reach the level where the launch control center was constructed. The shaft for the silo then was mined to its final depth of 174 feet. Contractors erected the silo walls using steel beams, wire mesh lagging, and sprayed-on concrete. A monumental steel frame equivalent in size to a 15-story building then was installed in the silo to support the missile and its ancillary equipment. The underground Titan complexes had separate launch control center silos that measured 40 feet wide and 40 feet deep; personnel tunnels and cableways connected the missile and control center silos.[212]

The unique requirements of the ICBM program and the compressed program schedule affected the construction effort beginning with the site selection process. Dozens of survey teams, comprising Air Force civil engineers, U.S. Army Corps of Engineers representatives, members of architect-engineer firms, and AFBMD personnel, combed the country in 1956-1957 during the selection process. Over 250 possible sites were investigated for the Atlas program alone. The teams surveyed sites from Washington State to Georgia and from New Mexico to New York.[213]

Site selection criteria were demanding and uncompromising. Optimum soil and geological conditions were required to enable the construction of underground silos that housed the Atlas F and the Titan missiles. Geography also was a criterion. Requirements established an 18 mile minimum distance between the missile complex and support base and between the missile complex and towns with populations of more than 25,000. Silos were spaced at seven mile intervals to ensure that each site constituted a separate target for incoming missiles. In addition, minimum buffers of 1,875 feet from inhabited dwellings and 1,200 feet from public highways were maintained.[214]

Final sites were selected from among the potential sites meeting technical criteria based on economic feasibility. Cost factors included a range of considerations such as the cost to dewater a silo or to construct roads. Costs for dewatering a silo could range from $50,000 to $200,000. Securing water in remote arid areas, such as eastern New Mexico, increased costs. Road construction could run as high as $70,000 per mile. Missile complexes located in remote areas from main bases necessitated extensive and costly expansions of base utility systems, and, in some instances, the construction of independent systems. Occasionally, construction at remote sites required upgrades to access roads and bridges used for construction equipment and to transport missiles to the finished silos. Final site evaluations entailed detailed analysis of all factors involved.[215]

On November 21, 1957, DoD announced that F.E. Warren AFB, Wyoming, would become the nation's first ICBM base, hosting six Atlas D missiles housed in two above-ground launch complexes. Each complex contained three launchers, known as a 6 x1 configuration. Bid packages for the

Table 2.3 Sites Selected for Atlas and Titan ICBMs

Atlas D	F.E. Warren AFB, Wyoming Offutt AFB, Nebraska
Atlas E	F.E. Warren AFB, Wyoming Fairchild AFB, Washington Forbes AFB, Kansas
Atlas F	Altus AFB. Oklahoma Dyess AFB, Texas Walker AFB, New Mexico Schilling AFB, Kansas Lincoln AFB, Nebraska Plattsburg AFB, New York
Titan I	Lowry AFB, Colorado Larson AFB, Washington Mountain Home AFB, Idaho Ellsworth AFB, South Dakota Beale AFB, California

construction of the launch and control facilities, located 23 miles northwest of Cheyenne, were opened seven months later on July 15, 1958. The Omaha District of the U.S. Army Corps of Engineers oversaw construction. The George A. Fuller Company was selected as the prime contractor. New construction techniques, the remote location, a compressed 190-day schedule, harsh weather, and constant design modifications combined to increase the difficulty of the assignment. Despite these challenges, the first Atlas D missile was delivered to the site on September 15, 1959 and the complex was declared operational on August 9, 1960.[216]

In February 1959, bids were opened for a second three-site missile complex near F.E. Warren. The Blount Company of Alabama submitted the winning bid to build Annexes B, C, and D. Each site accommodated three launches in the first 3x3 configuration. A third complex, under the jurisdiction of F.E. Warren, hosted nine Atlas E missiles built in the 9x1 configuration. Work began on December 7, 1959.[217] The selection of other ICBM sites followed (Table 2.3).

Three Atlas D locations associated with Offutt AFB near Omaha, Nebraska, were built as part of the FY59 MCP. ICBMs were to be deployed at three sites in the area, at Arlington and Mead in Nebraska and Missouri Valley in Iowa. The Malan Construction Company of New York City won the contract for the support facilities in March 1959. The main contractor subcontracted work to 46 subcontractors creating challenges in project coordination. The deteriorated condition of access roads to the sites caused delays in transporting equipment and workers. Labor unrest resulted in 20 work stoppages and delayed progress by at least a month. Construction also was affected by the nationwide steel strike in summer 1959. Despite these difficulties, the project was completed July 28, 1960. The schedule delay of only four months was a testament to the excellent working relationship between the Air Force and the U.S. Army Corps of Engineers. [218]

Two problems confronting engineers during the Atlas program related to power for the launch sites and the design of the overhead doors for the Atlas F silos. Engineers evaluated several alternatives for power generation, including diesel engines, nuclear, fuel cells, batteries, gas turbines, and various combinations available from commercial sources. The power supply had to be highly reliable, constant, and self-contained within the launch complex. The power supply source also had to be designed to absorb extremely high accelerations from nuclear blast-induced ground shock, or designed to be mounted on shock mounts. Both initial cost and on-going operating and maintenance costs were considered in the evaluation of potential systems. Reliable diesel engines were selected to provide the principal power to the sites. A typical Atlas site was powered by four 1,000 kW units supporting a cluster of missiles.[219]

An Atlas F underground silo under construction at Plattsburgh AFB, New York, ca. 1961.

The design of the overhead doors for missile silos also posed a special engineering problem. The doors sealing the 300-square-foot opening for the Atlas F silo protected the missile from extreme weather, from nuclear blast waves and radiation, and from structural rebound. The doors could not affect the firing and guidance of the missiles, had to open fully within 30 seconds, and operate in sequence with the missile countdown procedure. The design also had to enable assembly, installation, and testing in the field. Many door designs were evaluated, but all had drawbacks that led to their elimination. Finally, a double-hinged, double-leaf, flat door design was accepted. A secure seal between the two door leaves was achieved through a wedge design. The door seal was reinforced by

This mammoth excavation near Denver, Colorado, will soon be an almost invulnerable underground launch site for the Air Force Titan ICBM.

a step mesh with a neoprene gasket. Heavy instantaneous loads on the main actuating mechanisms were eliminated by four short-stroke hydraulic actuators that operated in sequence prior to the main actuators and broke the door seal. The small actuators were effective particularly in icy weather or similar conditions leading to extremely tight seals in the door units.[220]

The Titan ICBM introduced a further level of sophistication in underground construction. A Titan I complex was a self-contained, underground village. Hardened to survive a nuclear attack, the complex, including the silos, control center, power house, and other support facilities, was constructed more than 40 feet underground and connected by over a half mile of tunnels. The tunnels comprised corrugated steel tubes 10 feet in diameter. Joints within the tubes gave the tunnel system flexibility and made it less vulnerable to damage from earth shock or blast. Blast locks with massive blast-resistant doors were installed at critical points in the tunnels to isolate shock waves.[221]

In March 1958, the Air Force selected Lowry AFB to be the first Titan I base. A joint venture led by Morrison-Knudsen was awarded the construction contract and work on three, three-silo complexes began May 1, 1959. Morrison-Knudsen completed the project on schedule and achieved the lowest construction costs of any ICBM base in the country at the time. SAC activated the first Titan I squadron at Lowry in 1960, construction was completed in August 1961, and the first Titan I missile squadron was declared operational on April 18, 1962.[222]

Construction to support the missile program extended beyond the launch bases. The FY58 and FY59 budgets for the Directorate of Installations also included provisions for facilities to support control operations at Sunnyvale, California; tracking and telemetry in Hawaii; Alaska; Point Mugu, California; and New Boston, New Hampshire; and, a defense alarm readout station in Alaska.[223]

Minuteman

As the Atlas and Titan programs unfolded, the Air Force recognized that that first generation of cryogenic liquid-fuel missiles developed under these programs was of limited use. The early Atlas and Titan missiles were dangerous to operate, expensive to maintain, and difficult to deploy due to the hazards of their caustic, volatile liquid-fuel systems. The silos that housed the missiles were oversized to accommodate the complicated propellant-loading system, which included storage tanks, piping, and pumps to handle hundreds of thousands of pounds of gaseous helium, liquid oxygen, and RP-1 fuel. It took 15 minutes to pump 249,000 pounds of propellant aboard the "quick firing" Atlas F.[224]

By 1957, propulsion engineers at the WDD were convinced that solid fuels were superior propellants for future missiles. Col. Edward Hall designed a family of relatively small, low-maintenance, solid-fuel missiles of tactical, intermediate, and intercontinental range, dubbed the Minuteman. In February 1958, Colonel Hall briefed the Secretary of the Air Force, the Secretary of Defense, and SAC commander Gen. Curtis LeMay that an arsenal of 1,600 Minuteman missiles could be manufactured and deployed by 1965. Typifying the speed of the missile program, the Air Force authorized AFBMD to begin limited R&D on the Minuteman within 24 hours.[225]

The Minuteman relied upon solid fuel in each of its three stages, thus eliminating many of the storage and handling problems associated with liquid fuels. Minuteman missiles launched immediately from silos, which were considerably smaller than the Atlas and Titan silos. The Secretary of Defense approved construction of the R&D test facilities of the Minuteman program at Patrick AFB and Edwards AFB in January 1959. In September 1959, the Boeing Airplane Company was selected as the Minuteman assembly and test contractor.[226]

Surveys for possible locations to base the Minuteman were initiated in late 1959. The majority of the strategic Soviet targets fell within the range of Malmstrom AFB, Montana, making the former World War II airfield the logical choice for conversion into a missile control base. The Air Force selected Malmstrom AFB to host the first Minuteman ICBM wing on December 23, 1959. The U.S. Army Corps of Engineers, Seattle District, handled land acquisition for the required base expansion.

Some 5,200 separate tracts scattered across 20,000 square miles of north-central Montana were secured. Groundbreaking for Minuteman construction at Malmstrom took place in March 1961.[227]

Air Force civil engineers executing the missile facility programs, from early anti-aircraft missiles to the complex ICBMs, demonstrated their professionalism, engineering acumen, and ability to meet complex engineering challenges within demanding schedules. Their stellar performance expanded the role of civil engineering in support of the Air Force mission, as well as enhanced the professional profile of Air Force civil engineers among their counterparts in the other U.S. Armed services.[228]

Construction of the U.S. Air Force Academy

The U.S. Air Force Academy (USAFA) established two important precedents in Air Force Civil Engineering. For the first time, the Air Force was authorized to act as its own design and construction agent for a major construction project. The U.S. Air Force Academy also marked the first time that a service academy was designed and built in its entirety as a holistic project.[229]

Since its inception, Air Force leaders had promoted the establishment of a separate Air Force Academy to educate young people for service as Air Force officers and leaders. In August 1948, a board was formed to discuss the creation of an air academy. The recommendations issued by the board included the creation of an undergraduate air academy that did not include flight exercises. In 1949, Secretary of Defense James Forrestal appointed a Service Academy Board to study the proposal. The board was chaired by Dr. Robert L. Stearns, president of the University of Colorado. Dwight D. Eisenhower, then president of Columbia University, served as vice chairman. Completing the membership of the board were the superintendents of West Point and Annapolis and several leading U.S. educators. The board heartily endorsed the proposal for a separate academy for the new service.[230]

The Engineering Standards Branch of the Planning Division at the Directorate of Installations was involved initially in site planning; investigational engineering and advance design for the academy commenced soon thereafter. All efforts came to fruition on April 1, 1954, when then President Eisenhower signed Public Law 325, officially establishing the USAFA. The law authorized the appropriation of $126 million for the school's construction.[231]

Communities across the country vied for selection as the permanent home of the USAFA. The Site Selection Committee traveled more than 20,000 miles and inspected potential sites in 22 states. The committee eventually narrowed the field of candidates to three locations, which were recommended to Secretary of the Air Force Harold E. Talbott for final action: Lake Geneva, Wisconsin; Alton, Illinois; and Colorado Springs, Colorado. Following numerous surveys and engineering studies, the Secretary announced the selection of a 15,000-acre site north of Colorado Springs in June 1954. Secretary Talbott also announced that interim classes would be held at Lowry AFB, Colorado for the first three classes of cadets while construction of the USAFA was underway.[232]

The Air Force created a new organization to oversee the high-profile project: the Air Force Academy Construction Agency (AFACA). Activated on June 4, 1954, the AFACA was assigned to the 1130th Air Force Special Activities Group, 1020th Air Force Special Activities Wing, Fort Myer, Virginia, for administration, with operational control vested in the Assistant Chief of Staff, Installations, Maj. Gen. Lee B. Washbourne. The AFACA's mission was to "direct the planning, designing, and construction of an Air Force Academy and to simultaneously assist in the provision of facilities for the interim Academy." Col. Leo J. Erler, formerly the Director of Construction for the Assistant Chief of Staff, Installations, became the first AFACA Director. Lt. Col. Clarence A. "Bud" Eckert and Mr. John P. Huebsch also were reassigned to the new agency. Col. James A. Barnett served as chief of the AFACA's Construction Division from 1954 to 1958.[233]

In October 1954, AFACA personnel was authorized at 15 military and 58 civilians, but that number soon increased to 17 military and 88 civilians, who worked from two offices—Washington, D.C., and Colorado Springs. At the end of January 1956, Colonel Erler stepped down as Director and was succeeded by Col. Al Stoltz, who remained in the job until the USAFA was complete. Colonel Erler retired from active duty and later accepted a civilian position as Liaison Representative in the Washington, D.C. office of the AFACA.[234]

Although a location had been selected, real estate acquisition proved to be a lengthy process. The State of Colorado, which enthusiastically had lobbied to become the home of the USAFA, created the Colorado Land Acquisition Commission to secure the required land and property rights. The Colorado legislature generously authorized $1 million to acquire land through purchase or condemnation, which would be subsequently donated to the Federal government. The Air Force agreed to cover all acquisition costs over $1 million.[235]

More than 300 architect-engineer firms expressed interest in the USAFA project. A board of key officers and civilians reviewed proposals and heard presentations from numerous companies. On August 15, 1954, Secretary Talbott selected the firm of Skidmore, Owings and Merrill (SO&M) of Chicago, Illinois, as the architect-engineer for USAFA. Three other firms were associated with SO&M on the project: Syska & Hennessy; Moran, Proctor, Mueser & Rutledge; and, Roberts and Company.[236]

AFACA personnel established the project requirements, which served as a guide for the design and construction of the USAFA. Members of the agency and representatives of the architect-engineer team visited other U.S. institutions of higher learning, including the U.S. Military Academy and U.S. Naval Academy, to gather data that informed planning for the facility.

On May 14, 1955, SO&M presented the USAFA's architectural concept to the public. In attendance were more than 100 members of the media and more than a dozen congressmen and senators. The architect-engineer firm showcased architectural renderings and a scale model at the Fine Arts Center in Colorado Springs. Some 25,000 people viewed the exhibit during the month that it was on display. The architectural vision for USAFA was rooted in the International Style and captured the public's interest. Glass, masonry, and aluminum were the principal materials of the building facades, while reinforced concrete and steel were used as principal structural materials. The buildings, although monumental in scale, were dwarfed by the majesty of the towering Rocky Mountains and augmented the natural beauty of the site.[237]

The International Style was a compatible image for the Air Force, the country's newest military service and one that defined itself by looking to the future and new possibilities. The modernist aesthetic spoke to that vision. The overall design was based on a seven-foot grid. Variations on the grid united the USAFA campus and created linear connections throughout its buildings that extended even to the buildings in the support area. The heating plants were described as being among the most handsome buildings at USAFA.[238]

Comments on the design generally were favorable and the concept design received critical support from the nation's leading architectural magazines. However, as the official history notes, "the model representing the cadet chapel stimulated some criticism." The extensive use of glass in USAFA's design prompted the House of Representatives to withhold approval for construction funding for fiscal year 1956 until the design could be further reviewed and "more firmly established." Plans were revised and the Air Force presented an acceptable design to Congress before final passage of the 1956 appropriations bill; an initial $20 million for construction was appropriated.[239]

Meanwhile, work to support the interim academy at Lowry AFB proceeded. Almost all of the buildings necessary to support the interim academy existed, although many required modification for academic use. The Denver office of Wilson & Company of Salina, Kansas, received the architect-engineer contract for the work at Lowry AFB. The majority of the contracts were awarded by the end of December 1954. Construction was completed on schedule by June 1, 1955 and within the $1 million budget. The first class of 306 cadets was sworn in and enrolled in July.[240]

The Air Force began to award contracts for utility and road construction at the USAFA site in June 1956. This initial work included the construction of the first 25 of the anticipated 70 miles of roads and three 800,000-gallon potable water reservoirs, as well as the construction of a 400-foot tunnel through the Rampart Range, which was part of the water supply system. Water to the site was provided by the City of Colorado Springs; the high-temperature hot water system for USAFA, when complete, was expected to be the largest of its kind in the United States.[241]

As work progressed, it became clear that the original design and construction schedule established by AFACA, and agreed to by the architect-engineer, was completely unworkable. After a lengthy analysis, which included review of the construction industry capability and the availability of critical materials, all parties agreed to a revised schedule. With the concurrence of the Secretary of the Air Force, the opening of USAFA was rescheduled from 1957 to September 1, 1958.[242]

The all-important work on roads and utility systems continued throughout 1956. Graders carved roads into the forested mountainsides. New water lines and sewer mains formed an underground network throughout the site. Land acquisition neared completion as the final tracts were acquired through condemnation. In all, 18,514 acres were acquired and included 632 acres of right-of-way for two railroad lines, U.S. Highway 85-87, and the City of Colorado Springs. The total cost of land was approximately $4.75 million, of which, about $4 million was reimbursed to the Colorado Land Acquisition Commission by the Federal government.[243]

The Secretary of the Air Force approved the final exterior designs for nearly all buildings in the academic area in March 1956. Final designs for the chapel were not selected, but its general size and location were approved. The revised site plan called for the chapel to be located among the academic buildings, rather than isolated on a hillside as initially proposed. The Secretary toured the site in early 1957 and approved the final design for the chapel on May 15, after receiving the joint approval of his consultants.[244]

USAFA was designed for a cadet wing of 2,500, although the initial number would be much smaller. The principal buildings in the academy included a dining hall, cadet quarters (Vandenberg Hall), academic complex (Fairchild Hall), administration building (Harmon Hall), theater (Arnold

U.S. Air Force Academy under construction with the Colorado Rockies as a dramatic backdrop.

Hall), physical education facility, and chapel. In addition, 1,200 family housing units (650 enlisted and 550 officers) under Title VIII Capehart were planned as dwellings for faculty members and to house the officers and Airmen of the support organization. Plans also called for an athletic area, a hospital, and a community center. A jet-capable airfield to support cadet flying training was eliminated from the original construction program due to cost. Luckily, the USAFA property encompassed the former Pine Valley Airport, which was adequate for basic flight training. An early agreement provided that Federal funds would not be used to build the football stadium. Fundraising for the stadium was undertaken primarily by the Air Force Academy Foundation, which was chartered in July 1954. The renowned designer Robert Trent Jones, Sr., was commissioned to design the golf course, which was financed by non-appropriated funds.[245]

Construction accelerated rapidly with the award of contracts. By mid-1957, 2,400 people were working on the site. The number grew to 5,500 in mid-1958. Congress increased the authorization for USAFA construction to $133.5 million; work under contract in the last half of 1957 rose from $75 million to $118 million. Construction experts from all over the United States helped build the nearly self-sufficient city capable of supporting a population of more than 10,000 students, faculty, and operations staff. Colorado Springs, normally a quiet city during the winter months, became a year-round boom town. Thousands of construction workers, many accompanied by families, swelled the local population. With the influx, local merchants began to appreciate the economic benefit that a permanent Air Force presence would bring to the larger community.[246]

The challenge of relocating the roadways and railroads previously established on the USAFA site led to innovative solutions. Pre-stressed concrete girders with 120-foot spans and weighing 96 tons were fabricated and shipped to the site. The girders, billed as the world's largest at the time, were used to create one of the longest span railroad bridges in the United States.[247]

Extraordinary construction techniques also were employed to construct the cadet dining hall, which featured a unique 1,150-ton roofing system. The roof was supported by 16 monumental columns spaced with 266-foot spans to create a large unobstructed space to accommodate the assembly of the entire cadet corps at one time. With overhang, the roof covered 308 feet square. Workers assembled 12-foot trusses on the dining hall floor and then raised the roof in January 1958 using the concrete slab method. It was reported to be the first time that the process was applied in the construction of a large steel structure.[248]

Contractors faced numerous obstacles as they worked to meet the September 1, 1958 deadline. The weather did not cooperate and 1957 was one of the wettest years in the region's history. Precipitation totaled 25.07 inches, compared to normal annual totals of 14.26 inches. Two April snowstorms deposited 36 inches of snow on the high-altitude site, and May was the fourth wettest month on record. During one of the heavy snows in April, members of the Academy Board of Visitors, composed of prominent civic and government leaders appointed by President Eisenhower in February 1956, visited the site by helicopter. They expressed concern over the approaching deadline, but AFACA assured them that obstacles would not affect the overall schedule.[249]

High public interest in USAFA translated to a large volume of official and unofficial visitors. An estimated 125,000 people visited the construction site in 1957 alone. Another notable challenge in 1957 was posed by a five-week steel strike that caused delays in delivery of steel columns and girders. February 1957 was marked by the death of Lt. Gen. Hubert R. Harmon, the first superintendent of USAFA, who oversaw the completion of the interim campus at Lowry AFB and welcomed the first class of cadets. A decorated World War II veteran, General Harmon had retired twice from the Air Force, but returned to active duty at the request of fellow West Point classmate, President Eisenhower, in November 1953 to serve as the special assistant to the chief of staff for academy matters. General Harmon retired as superintendent in July 1956 and died at Lackland AFB the following February. He was succeeded as superintendent by Maj. Gen. James E. Briggs.[250]

The pace of construction accelerated in 1958 as AFACA directed efforts toward completing sufficient facilities to permit operations to begin by September. On January 1, the value of completed construction work stood at $60 million. Six months later, that figure reached $90 million—an average of $5 million of completed work per month. On December 31, the total of the work completed had risen to $108 million.[251] During 1958, work focused on the principal academic area buildings. Most major facilities, such as the cadet quarters, academic complex, science building, cadet dining hall, heating plants, parade ground, and support personnel facilities, were completed or nearing completion by the end of the year. Rapid progress continued on the Capehart housing complexes in Pine Valley and Douglass Valley, which were built at a cost of $19 million through a joint venture between the Del E. Webb and Rubenstein Construction companies.[252]

Gradually, AFACA turned responsibility for facilities over to USAFA. In early 1957, the USAFA's 7625th Support Squadron was activated as the base support organization. The unit began receiving and storing supplies and equipment and assumed the job of operating and maintaining permanent facilities. On June 30, 1958, command jurisdiction of the site was officially transferred to the USAFA superintendent. On the same date, the AFACA contract with the General Services Administration for interim security and fire protection was terminated, and the USAFA assumed full responsibility for those services.[253]

Labor Day weekend in 1958 was a memorable occasion for the Air Force, especially for those Air Force engineers who had worked on the USAFA since 1954. Over that weekend, General Briggs and the entire Cadet Wing moved to the USAFA from the interim campus at Lowry AFB. The first graduating class completed its final year in the new academic complex and graduated in June 1959. The festivities attracted hundreds of thousands of visitors.[254]

The U.S. Air Force Academy's iconic Chapel takes shape as the spires are set in place.

Behind the scenes, construction continued in the housing areas and contractors put the finishing touches on the cadet physical education complex, the cadet social center, and the USAFA's landscape plan. By the end of 1959, all but two projects had been completed: the chapel and the hospital. B.H. Baker, Inc. of Colorado Springs was awarded the $3.5 million contract for the hospital.[255]

The USAFA chapel continued to attract controversy. Bids were opened on July 21, 1959 and AFACA awarded the $3.33 million chapel construction contract to Robert E. McKee, General Contractor, Inc. The chapel would become the dominant feature of the campus and an architectural icon. Work began in September 1959, but was plagued by defective aluminum roof panels. Selected interior work, financed by Chaplain funds, was rescheduled to coordinate with the building construction sequence.[256]

AFACA extended the construction contract by 97 days. The beneficial occupancy date was set for December 31, 1961, then moved to February 1962, and reset for March 17, 1962. Construction deficiencies in the weather tightness of the structure delayed final acceptance of the building. After extensive review of the proposed remediation, a final solution to water penetration into the chapel was identified and a change order in the amount of $237,550 was negotiated with the contractor. Formal dedication of the chapel took place on September 22, 1963.[257]

During 1960, AFACA decreased its staff commensurate with the level of outstanding construction work. From a high of more than 120 personnel, the staff had shrunk to 8 civilians and 9 military by mid-1961. The remaining personnel closed out projects and completed as-built drawings and operations and maintenance manuals for the last few outstanding buildings. The agency incrementally ceded office space in the Bradford Building in Colorado Springs, its home since 1954, to Air Defense Command, which shared the building. AFACA officially was inactivated on June 30, 1962. SO&M closed its local office and the major effort of building the USAFA came to an end.[258]

Construction of the USAFA was a source of great pride for the Air Force. The project involved complex acquisition of land and more than 100 major building contracts. Effective and efficient management demonstrated the skill of Air Force civil engineers in handling extended and complex design and construction projects. The final total cost of the USAFA was approximately $141.8 million, plus the cost of projects that were sponsored privately.[259]

Overseas Construction

During the early 1950s, the Air Force oversaw a robust overseas construction program monitored by the Construction Division in the Directorate of Installations. In response to the expanding program, the Overseas Section became a separate branch within the division in 1952. By 1954, that office was overseeing a program valued at approximately $2 billion.[260] Overseas bases were of particular concern for SAC and MATS. MATS required a worldwide basing system to provide air transport for people, materiel, mail, strategic materials, and other cargo through regular flights or flights scheduled on an as-needed, emergency basis. MATS flew the largest aircraft in the Air Force inventory. SAC required overseas bases to launch bomber strike forces against enemy targets. At that time, no aircraft launched from the U.S. could reach enemy targets in the U.S.S.R. without stopping to refuel at intermediate bases. Initially, SAC stationed its bomber crews overseas on a rotational basis. By 1954, SAC recalled all bombers in the United States and stationed aerial refueling tankers in the northeastern United States, Canada, Bermuda, and Greenland. Overseas bases continued to be important as landing sites for aircraft that had completed their missions and for launching follow-on missions.[261]

While the U.S. already had acquired a number of overseas air bases during World War II, many were not in strategic locations and all bases needed substantial upgrades to support newer, heavier aircraft. In 1952-1953, the Air Force construction program focused on completing air bases in the United Kingdom, Europe, and northern Africa. One high profile project was the construction of four bases in French Morocco. Other bases were constructed across the northern tier of Africa and included Sidi Slimane, Tunisia; Wheelus, Libya; and, Dhahran, Saudi Arabia. Still other bases included the construction program were located in Canada, Iceland, and Greenland; Thule Air Base in northwestern Greenland was constructed during this time. While the U.S. Army Corps of Engineers oversaw much of the overseas construction work through its district offices, the Air Force also was involved through the AFIR offices in Casablanca, Morocco, and Paris, France. In the Far East, all construction work was delegated to the Far East Air Force Command.[262]

The Joint Construction Agency (JCA) was officially established by the DoD on January 15, 1953 to oversee all construction in Europe with the exception of Germany. While projects proceeded on schedule in Germany, construction had come to a halt in the remainder of Europe despite funding and support from the U.S. Congress. The JCA, with an initial staff of three officers representing the Air Force, Army, and Navy, was aligned directly under the United States European Command. The DoD established the JCA with the objective of achieving economy and efficiency. Joint effort among services replaced the potential for competition. In addition, needless duplication of construction could be avoided and uniformity in criteria, standards, designs, and construction could be implemented.[263]

The JCA was modeled after the U.S. Army Corps of Engineers; military officers controlled the agency, but civilians staffed the majority of positions. JCA Headquarters was responsible for the general supervision of construction and cooperation with the local government and agencies. Each service commander identified sites and negotiated land acquisitions.[264]

The JCA initially focused on construction in France. From the beginning, the JCA encountered problems with French authorities, DoD, and within the program. The first year was devoted to transferring construction responsibilities to the JCA.[265] Within the first two years of the agency's existence, the DoD enforced two freezes on construction projects in France. These freezes challenged the authority and credibility of the JCA. Construction in France further was hampered by negotiations during 1950-52 that placed oversight of all U.S. military construction under three French agencies. The French government was adamant that projects be presented to one of the agencies at each phase of work. Additional problems arose over differences in administrative techniques between the United States and France. Within the JCA, continual delays occurred with constant revisions to construction plans and criteria.[266]

Brig. Gen. John D. Peters described the JCA project, which he supervised as a captain,

> The project that I had, under the Bordeaux district, was to build an ammunition depot in the forest of Chizé, which is about 400 kilometers south of Paris….The depot was an Air Force facility for bomb storage and ammunition storage and rework. It consisted of some 150 or 200 ammunition shelters, made out of corrugated metal, a cantonment area, a motor pool area and motor pool repair, a water tower, and the administrative buildings that went with this cantonment area, with the barracks and the mess hall and the officers' quarters…. The whole project was about $20 million. Most of the facilities were built out of concrete block, and it wasn't supposed to be painted. The roads in the forest of Chizé were designed for heavy loads. The design was the same in the cantonment area, with two-and-a-half inches of asphalt, even though we weren't going to have anything heavier than cars and light trucks in that cantonment area. I negotiated with the contractor to trade a half-inch of asphalt in the cantonment area for enough money to paint all the buildings inside and out. The buildings were all white with a pretty forest green trim. We painted the insides with a colored fleck in it. As far as I know, when it was finished it was the first painted complex that had been built in that district. It was the first project finished on time, and it was the first project that had money left on it.[267]

Operations were initiated outside of France in 1954 when the JCA assumed responsibility for Army and Air Force construction in Austria and Italy. However, the Engineer Division of United States Forces, Austria, maintained management. On May 15, 1955, the Austrian State Treaty was signed and

The Joint Construction Agency constructed a NATO ammunition depot in the Forest of Chizé near Niort, France, in 1947.

recognized Austria as a sovereign state. Under the treaty, evacuation of all occupying militaries was required. U.S. forces withdrew to Italy, a move that necessitated the rehabilitation of several bases. The JCA assisted the Army command in Italy, Southern European Task Force (SETAF), as well as supervised the construction of five Air Force bases and facilities on two naval bases. Also in 1954, the JCA opened an office in Athens to oversee construction in Greece and Turkey. The United States Engineer Group (TUSEG) established in Turkey during 1950 was placed under the authority of the JCA. Construction, primarily for the Air Force, continued in Turkey.[268]

By the mid-1950s the demand for military construction in Europe abated. The DoD determined that the JCA was no longer necessary and that previously completed projects met the immediate needs of the military. On August 1, 1957, the JCA was disbanded. During its short history, the agency had succeeded in organizing construction programs in France and Europe and had completed several large projects, including essential billeting, POL systems, and hospitals. Responsibility of military construction in Greece, Italy, and Turkey shifted to the Mediterranean Division under the Office of the Chief of Engineers in Washington, D.C., while construction in France was passed to a new agency, the United States Construction Agency under the United States Army European (USAREUR).[269]

MANAGING THE BASES

The Air Force was assigned repair and maintenance responsibilities for air bases under War Department Circular 388 dated September 27, 1944. However, the U.S. Army Corps of Engineers retained practical supervision over the performance and funding of air base maintenance until 1946, when all technical supervision was transferred to the Army Air Forces.[270] These functions subsequently transferred to the newly established independent Air Force in September 1947. The Air Force faced immediate challenges with establishing and staffing base-level organizations. The first requirement was to define responsibilities, and then to establish effective procedures to maintain the bases in light of the ever-growing effort necessary to support Air Force missions. The Air Force created these new organizational structures through an ever-expanding series of Air Force Regulations (AFRs). During its first two years of existence, the Air Force issued joint regulations with the Army for contract construction and real estate. By 1950, the Air Force was issuing its own regulations to establish the base organization and to guide base maintenance and management operations.

The role of the AIO changed dramatically between 1947 and 1960. At the beginning of the time period, the AIO was considered primarily as a custodian of the buildings and grounds that the Air Force inherited after World War II. By the early 1950s, the AIO, later renamed the installations engineer, assisted in siting new facilities through the master planning process. Installations engineers also kept pace with the increasingly sophisticated engineering requirements to support the Air Force mission. Whatever facilities that the Air Force built, the installation engineers maintained and operated. Technological changes had dramatic impacts on facilities maintenance and operation. Jet aircraft required longer and wider runways and stronger pavements. Refueling facilities evolved from tanker trucks to high-speed underground hydrant systems. Aircraft wing spans increased, requiring the construction of wider hangars. By the early 1950s, Air Force installations numbered approximately 2,000, including 500 major bases. The types of installations overseen by installations engineers included operating bases, depots, headquarters, aircraft plants, bombing ranges, radar and early warning missile tracking stations, missile silos, research facilities, and space-related installations. The environment in which the installations engineers operated comprised CONUS and far-flung worldwide locations ranging from tropical jungles, to arid deserts and polar regions. The value of the facilities inventory overseen by the installations engineers increased from $3.1 billion in 1950 to $8.9 billion in 1958.[271] As Maj. Gen. Lee B. Washbourne summarized the job of the installations engineer:

> he is a city manager with such additional duties as fire chief, water commission, street commission, building inspector, chief plumber, landscape consultant, mosquito eradicator, and father-confessor to his squadron. In his more leisurely moments (if any) he clears runways of snow and ice, and advises the station commander about new construction progress and Wherry housing for families.[272]

Air Installation Officer Responsibilities

Early regulations for Air Force base-level organizations were patterned after Army regulations. Army Air Forces Regulation 20-42 dated July 13, 1944 identified the Post Engineer as an officer on the staff of the air base commander, who was responsible for repairs and utilities work.[273] By 1945, the primary duties of the Post Engineer were defined in a revised two-page regulation as:

- Procurement of utilities and repair, maintenance, and operation of utilities, plants, and their systems;
- Maintenance and repair of buildings, structures, civilian war housing on installations, roads, runways, utility distribution systems, airfield lighting systems;
- Duties of base fire marshal with oversight of the base firefighting and prevention programs;
- Maintenance, repair, and operation of power-operated or immovable kitchen equipment, ventilation and air conditioning equipment, and shop equipment used for maintenance and repair;
- Construction, maintenance, repair, and operation of shops to accomplish all installation repairs and utilities activities;
- Performance of insect, rodent, and pest control measures; and,
- Establishment of procedures for preparation of current real property records and reports, cost accounting, and for the storage, receipt and issue of all materials, supplies, and equip ment pertaining to maintenance, repair and operation of structures, grounds, and utilities.[274]

In 1946, the position was renamed as the air installation officer (AIO) and maintenance activities became a command function under the oversight of the AIO. Additional responsibilities assumed by the AIO included the management of real estate and custodial services.[275]

The five-page AFR 20-42 issued in February 1948 detailed the responsibilities of AIOs in the newly established Air Force. The overview statement of the AIO's duties read as follows:

> The air installation officer will, as a staff officer of the installation commander, supervise, direct, and coordinate real estate management; fire protection and aircraft crash-rescue activities; air installation facilities rehabilitations, alterations, extensions or additions, deletions, relocations, and restoration of damage caused by disasters; and repair, maintenance, or operation of buildings, structures, grounds facilities, utilities, or other real property improvements, including new construction under the jurisdiction of the installation commander at any Air Force installations.[276]

Other duties included oversight of installation master planning; performing technical inspections of new construction and existing building and grounds; furnishing electric, water, sewage, and other utilities; pest control; custodial services; refuse collection and disposal; and, snow removal.[277] In addition, the AIO commanded the installations squadron within the air base group and wing base structure.[278]

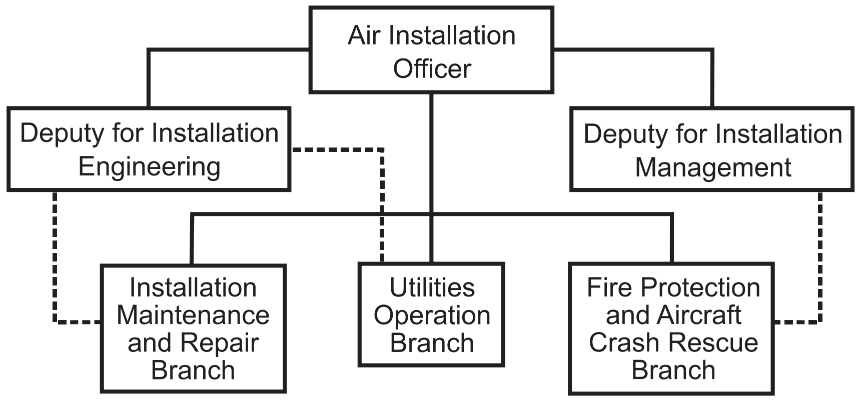
The fundamental duties and responsibilities assigned to the AIO remained consistent throughout the 1950s; follow-on regulations were developed to define those duties in greater detail. On January 1, 1952, the AIO job classification was renamed "Installations Engineer" in the AFSCs in the Officers Classification Manual.[279] The management of the base-level organization continued to grow in complexity as did the number and specialization of the facilities on the bases. The 1956 revision to AFR 20-42 addressed the administration of the branches of the installations engineer organization in great detail. For example, management of the shops and work flow control procedures were outlined. Selected new duties were added, such as responsibility for a preventive maintenance program and base recovery following attack, which was included by 1956, and traffic engineering, which was included in 1957.[280]

Air Installation Organization and Staffing

A standardized administrative structure to support the base-level air installation organization was described in AFR 20-42. The AIO was assisted by two deputies: Deputy for Installation Engineering and Deputy for Installation Management. Installation engineering services encompassed master planning; project development and design planning; project preparation and submission to major commands; preparation of contract and project specifications; drafting services; survey of sites for current and proposed facilities; performance of technical maintenance inspections for all buildings and grounds type of facilities; and, preparation of work orders to accomplish engineering projects. Installation management comprised the administration of real estate, cost and funds control systems, the inventory control system, and personnel, including fire protection and aircraft rescue personnel.[281]

The AIO oversaw three branches: Installation Maintenance and Repair, Utilities, and Fire Protection and Aircraft Crash Rescue (Figure 2.2). The Installation Maintenance and Repair Branch was responsible for the construction and repair of buildings, structures, grounds, utility systems, and field lighting systems, as well as maintenance of buildings, structures, and utility shop equipment. The operation of the shops to execute the work was administered under this branch. Base installation personnel were authorized to complete minor new construction, and modification and alteration of existing facilities; limits on installation authorization for in-house construction activities were established through cost ceilings. The Utilities Branch oversaw all base utility plants, and water and sewage treatment plants. This branch also was responsible for all heating, refrigeration, and air conditioning

Figure 2.2 Air Installation Officer Organizational Chart, 1948



Source: AFR 20-42, Organization, Air Installation Officer, February 6, 1948.

systems. The Fire Protection and Aircraft Rescue Branch was responsible for base fire prevention programs, firefighting, and crash rescue activities.[282]

During the late 1940s, the Air Force intensified recruiting efforts to attract an increased number of AIOs. Successful candidates needed a wide and sophisticated skill set in such fields as mechanical, electrical, civil, structural, sanitary, and management engineering, as well as agronomy and entomology. Faced with 350 officer vacancies, the Air Force recruited Air Reserve and Air National Guard officers who possessed the appropriate education and experience to transition to active duty with the Air Force. Recruits were sensitized to the wide diversity of engineering duties necessitated by air installation activities. These duties extended to firefighting and air crash rescue and personnel management. Officers eligible for additional training through the Air Installations Engineering Special Staff Officer Course were assured assignments at bases "representing a multi-billion dollar investment. The opportunity to work with modern equipment and experienced technicians and to manage personnel and equipment will add appreciably to the experience sheet and the ability of the officer ordered to this duty."[283] By 1956, Air Force installations engineers from the Air Staff through the commands to the installations numbered 1,500 officers, 30,000 Airmen, and 20,000 civilian employees. The typical staffing of the 144 installations squadrons comprised the installations engineer supported by 3 to 14 officer assistants, 150 Airmen, and 200 to 500 civilian employees. Civilians were employed in administration, at fire stations, and in technical areas, such as the maintenance trade shops and utilities.[284]

AIOs also served with major commands and as regional representatives. Each major and subordinate air command included an installations office similar in scope to that included in the Directorate of Installations at the Air Staff. At each CONUS and overseas command, the Director of Installations exercised technical and administrative supervision over the base-level air installation organizations in their respective commands. Additionally, one regional representative served in each of 11 regions of the world.[285]

Brig. Gen. John D. Peters recalled his experience in 1949 as a de facto assistant AIO. After enlisting in the Army in 1944, he reported for basic training at Fort Belvoir, Virginia. Since he had college experience, he was selected to attend the U.S. Army Corps of Engineers Officer Candidate School and was commissioned as a second lieutenant in March 1945 and sent to the Pacific Theater with the 47th Engineer Construction Battalion to build a road on Okinawa. After rejoining the Army in 1947, Lieutenant Peters was assigned to Japan and served in a succession of aviation engineer units to support Air Force bases as part of Special Category Army Personnel with Air Force (SCARWAF). In 1949, he transferred to the Air Force and reported for duty as the assistant AIO at Fairchild AFB in Washington.[286]

After working for several weeks with minimal supervision and few formal assignments, Lieutenant Peters took control of the situation:

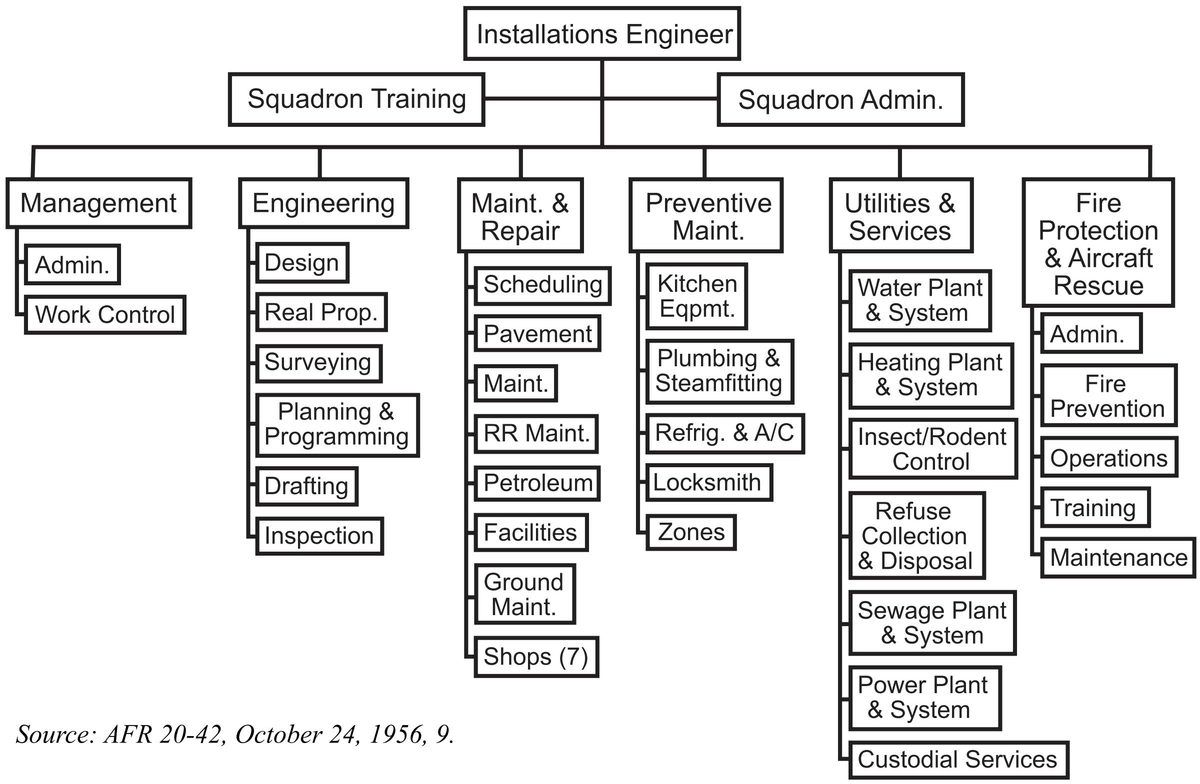
> I moved my desk into the middle of the secretary's pool. I discovered that there were drawers full of work order requests that had never been processed. Some were over a year old. I ran a notice in the daily bulletin stating that every organization that had submitted work orders that were more than 90 days old should resubmit them, if the work was still needed. I began going out to see what was requested, then approved or disapproved work orders and worked with the shops to schedule the work. I notified the client when the work would start or, if it was disapproved, the reason for the disapproval and suggested an alternate solution. [287]
>
> That worked fine for about two months, until I received a work order signed by the 98th Bomb Group commander. It was a request to move a light in an office in one of the concrete hangars from one corner of the room diagonally to another corner. The justification was "to get the light over the desk." It occurred to me that it would be easier to move the desk, so I disapproved the request and suggested the desk be moved. In about three days the base commander called my boss and asked what he had me doing. He answered that he didn't know what I had been doing. The base commander asked him to come to his office and bring me with him. When we arrived, he asked what I had done to the 98th Bomb Group commander, so I recounted the story of the rejected work order. I also told him that I was examining all work order requests and scheduling them to the shops to get the work done. I recounted the number and age of the work orders I had thrown out and explained that I had run the notice in the daily bulletin. The base commander said to me, "Keep on doing what you're doing," and dismissed us. We went back to the office and that afternoon I became the *de facto* Deputy Air Installation Officer.[288]

The structure of the AIO organization continued to evolve during the 1950s through experimentation with processes and procedures. By 1956, the Installations Engineer organization comprised six branches: Management, Engineering, Maintenance and Repair, Preventive Maintenance, Utilities and Services, and Fire Protection and Aircraft Rescue (Figure 2.3). The Management Branch performed the administrative work of the organization, including work orders and work control functions, personnel management, and reporting. The Engineering Branch prepared the annual military construction and

The alert crew of Preventative Maintenance, Air Installations, is responsible for the head emergency calls from the base at night, such as plumbing, electric cutoffs, and other items normally handled by the Air Installations Squadron.

The Home of Preventive Maintenance, Tyndall AFB's 3625th Air Installation Squadron, 1954.

Figure 2.3 Air Installations Office Organizational Chart, 1956



Source: AFR 20-42, October 24, 1956, 9.

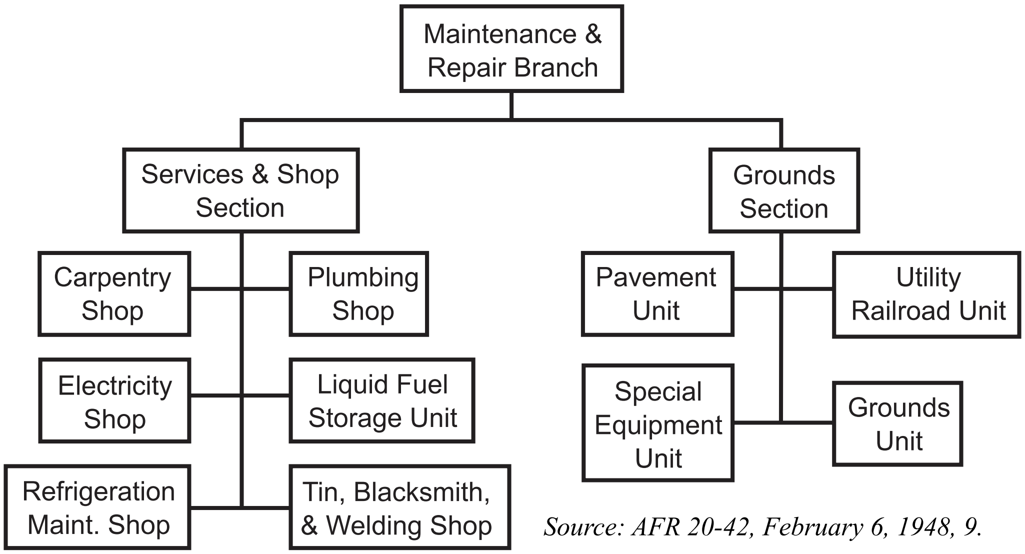
maintenance and repair programs for the base, technical project data and current data on conditions of facilities, real property records, and engineering drawings. This branch conducted inspections of construction projects on base and interfaced with construction agents and higher commands on construction projects. The Maintenance and Repair Branch oversaw the maintenance and repair of base facilities; the shops were organized under this branch. The Preventive Maintenance Branch, which was a concept introduced in the mid-1950s, established cyclical maintenance schedules for facilities and conducted systematic inspections to identify and undertake small routine repairs before they became larger problems. The Utilities Branch oversaw the procurement, generation, and distribution of utilities, including electricity, and water and sewage. The Fire Protection and Aircraft Rescue Branch continued its functions in providing firefighting and aircraft rescue services and overseeing the base fire prevention program.[289]

Maintenance and Repair

The maintenance and repair of facilities were overseen by the Installation Maintenance and Repair Branch. This branch was divided into two sections: Services and Shop, and Grounds (Figure 2.4). The Services and Shop section was responsible for construction and repair of structures and utilities. This section oversaw personnel organized by trades into the following specific shops: carpentry; plumbing; electricity; tin, blacksmith and welding; refrigeration maintenance; and, liquid fuel storage unit.[290] By 1956, the maintenance and repair branch expanded to include the following sections: scheduling; petroleum facilities maintenance; pavements maintenance: ground maintenance; railroad maintenance; carpenter shop; electric shop; refrigeration and air conditioning shop; sheet metal shop; plumbing and steam-fitting shop; paint shop; and, heating shop (Figure 2.5).[291]

Maintenance and repair activities were guided by AFR-85-5, *Maintenance of Installations,* which originally was issued in June 1950 and updated in June 1951. This regulation was one of the most important for installations engineers. The regulation defined activities involved in the maintenance

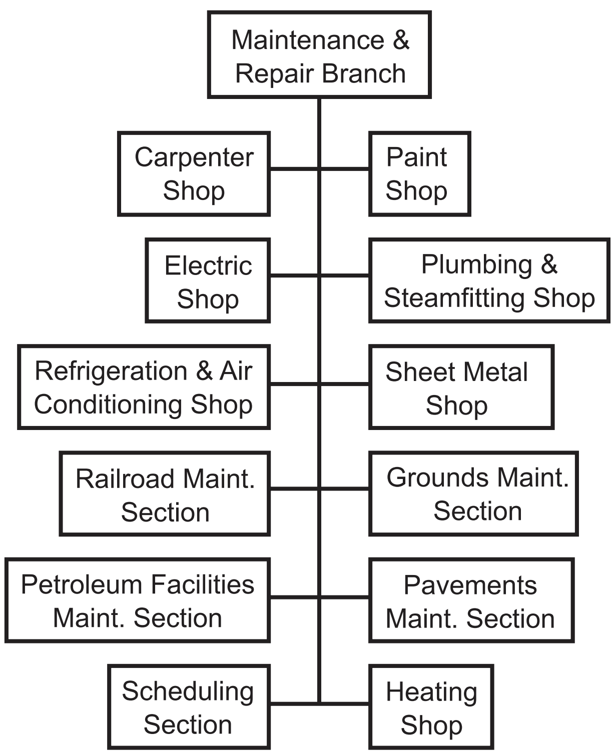
Figure 2.4 Maintenance and Repair Branch Organizational Chart, 1948



Source: AFR 20-42, February 6, 1948, 9.

of installations, described basic functions, and detailed Air Force policy for employing civilian and military personnel in the maintenance, repair, alteration, and new construction of real property on Air Force bases. The regulation also established basic standards for maintenance and administrative responsibility in the major commands for supervising engineering management. The regulation delegated responsibility to the major commands for supervision of engineering management functions at installations.[292]

Figure 2.5 Maintenance and Repair Branch Organizational Chart, 1956



Source: AFR 20-42, February 6, 1956, 12.

As General Peters recalled when he was an assistant AIO in 1949:

> [air installations squadrons] primarily operated under the guidance of the very first version of Air Force Regulation 85-5. That was kind of our Bible. It told you what to do and how to do it in kind of a cookbook way, but without many procedures. Procedures had to be developed. There was very little on things we think of today as being routine. There was a work order system—not a very good way of handling work orders. There was no logistics system that amounted to anything, no material control system. It was fine to get a work order into the system, but the manner of assigning priorities and making sure the work got done and quality assurance, all of that had to come later. It was a developing system and it was in its very early stages.[293]

During the 1950s, Lt. Col. (later Brig. Gen.) Archie S. Mayes earned a reputation for crafting the standards and regulations that came to define the base-level installations engineer organization and its operations. Colonel Mayes worked as an installations engineer on SAC bases for the majority of his early Air Force career. He served as an AIO at Castle AFB, California, from 1949 to 1952. In 1952, he was assigned to Fairchild AFB, Washington. He remained at Fairchild for two years before relocating to Loring AFB, Maine. He introduced innovative management solutions and developed creative ways to achieve base missions for installations engineers.[294]

Colonel Mayes was noted for his talent for developing working organizations in the midst of chaotic situations. At Fairchild AFB, Colonel Mayes found an installations squadron comprising approximately 700 military and 200 civilian personnel that was unprepared for its alert missions. Personnel were assigned to jobs for which they were not qualified. Shortly after his arrival at the base, Colonel Mayes assembled the personnel and presented a list of “40 Do’s and 40 Don’ts.” He informed the crowd, “This is how we’re going to run this railroad.” Colonel Mayes worked with Captain Peters, who was already stationed at Fairchild AFB as Deputy AIO, to evaluate job descriptions. The two future general officers together shook up the office by notifying individuals of their actual job descriptions. Some personnel, including the chief engineer, quit as a result. Others welcomed the change and asked to be reassigned to positions that better fit their qualifications. When Colonel Mayes left his position at Fairchild AFB in 1954, he observed that “instead of 900 people we had 500 and some-odd and we were doing 10 times the amount of work they were doing with 900-odd people, because people were doing their jobs.”[295]

The continuous expansion of the Air Force since 1951 resulted in a substantial increase in the number of physical facilities requiring maintenance. Installations engineers and the Air Staff continually strove to develop effective methods to accomplish maintenance and to control costs at the installation level. From mid-1954 to December 1955, field tests were conducted on new methods and procedures for preventive maintenance, transportation, organization, cost and property accounting, and effective controls of work flow. Results were disseminated to the installation-level through technical manuals, directives, and instructions.[296]

The preventive maintenance program became a particularly effective tool. Preventive maintenance was a command responsibility in accordance with AFR 85-5. On August 1, 1955, Air Force Manual 85-2, entitled *Organization and Management of P/M*, was issued.[297] By 1956, an organizational chart for the Preventive Maintenance Section was included in AFR 20-42.[298] The purpose of the Preventive Maintenance Section was to complete systematic inspections of Air Force facilities and to make minor repairs to real property on a “Find it-Fix it” basis. Installations were divided into maintenance zones comprising between 50 and 200 buildings. Combined teams of skilled maintenance workers worked out of mobile trailers. Specialty sections under preventive maintenance included kitchen equipment, plumbing and steam fitting, refrigeration and cooling, and locksmith.[299]

Another important regulation that affected maintenance was AFR 93-3, *Maintenance, Repair,* *Alterations and Minor Construction Projects*. This regulation defined funding limits and the types of projects that could be undertaken in-house by installations engineers. An important change occurred in the 1958 revision to this regulation. The revised regulation vested commanders with greater authority and flexibility in processing and approving major repair, modification, and minor construction projects. Larger project budgets now could be approved at lower command levels, thereby delegating maximum approval authority to the lowest possible echelon. Commanders were empowered with up to twice the authorization authority they formerly had under old procedures.[300]

The increased number and complexity of Air Force facilities and systems requiring maintenance necessitated accelerated operator-maintenance training programs. Recommendations for achieving higher skill levels and realistic training programs were made to training organizations. Conferences and training courses were conducted in selected areas. Consultants and technicians from industry contributed to the training sessions at no charge to the Air Force.[301]

Real Property Inventory and Master Planning

Maintaining accurate real property inventory records and base master plans were major responsibilities for the AIO. The real property inventory provided a wealth of data for the AIO: the total facilities available on the installation, facility age, square footage, and basic construction materials. The master plan mapped the locations of facilities, structures, and utilities on the base and identified areas available for new facilities. All new construction projects were linked to the master plan. The master plan provided graphic and tabular data on the current conditions at the base and also provided data for orderly base expansion and development.[302]

The development of base master plans was programmed in the FY50 Air Force budget. The Master Planning Branch in the Directorate of Installations initiated a phased program to develop master plans for all Air Force installations worldwide. Detailed data on geographic conditions of bases and facilities was collected under the first phase of the program. Preliminary master plans were prepared by contracted architect-engineer firms during the second phase.[303] In 1950, the Air Force published AFR 86-5, *Installations Planning and Development*, which detailed criteria and standards for the development of airfields.[304] The master plans of the 1950s typically comprised a series of drawings and overlays that detailed the locations of current facilities, utilities, and base data.[305]

The massive construction program completed between 1951 and 1953 overwhelmed the master planning process. All base master plans required review by major commands and received final approval by the Directorate of Installations at Air Staff. This approval was a prerequisite to new construction on a base. During the early 1950s, final approval of master plans presented a challenge due to the rapid expansion anticipated by the Air Force and the continuously changing number of wings. By July 1, 1951, approximately 60 percent of CONUS and 40 percent of overseas bases had approved master plans. When the existing 48 wing organization transitioned to the 95 wing, followed by the 126 wing expansion plan, many air bases with existing master plans experienced a change in mission. Changing missions necessitated revisions to master plans and $2.5 million was contracted to architect-engineer firms to update the documents. By the end of 1951, master plans were received from 154 of the 184 installations with authorized master planning; 107 of those master plans were approved.[306] When the number of bases was increased under the 143 wing plan in July 1, 1953, 70 percent of CONUS and 75 percent of overseas bases claimed approved master plans.[307]

In March 1954, the inventory of facilities on Air Force installations worldwide was completed. The data was forwarded to the Director of Statistical Services, Deputy Chief of Staff/Comptroller. This office compiled the data on punch cards for record keeping using an early automated system. The 1954 effort was the basis for a real property inventory of active installations that was kept current by the Assistant Chief of Staff, Installations.[308]

In June 1954, a new set of instructions was issued to detail the quality, quantity, and type of data appropriate for inclusion in Master Plans. The revised procedures resulted in a marked increase in the cost of developing and preparing master plan reports, but the net result was more accurate and efficient master plans. A major Air Staff decision was issued to adopt a "Multi-purpose Air Base Planning" concept for master planning wherever practicable, particularly in the design of installations for dispersed elements of tactical aircraft units. The multi-purpose air base concept allowed more flexibility in the arrangement and spacing of air base facilities to meet substantially increased mission requirements.[309]

Installations engineers played an important role in new construction on the bases. Base installations engineers worked with construction agents and higher commands on facility siting applying the base master plans. Often, on-base personnel were the best informed about local conditions that might impact construction. General Mayes, recalled an incident while he was the AIO at Castle AFB, California, between 1949 and 1952,

> When I was at Castle [AFB, California] we got the first military construction program. I think the first time we had it, it was a munitions area and a barracks. That was a long story, because the [U.S. Army] Corps of Engineers came in and their attitude was that Air Force officers didn't know a damned thing. I mean it was a really terrible attitude. The resident engineer there looked down his nose at me. They built a munitions area, and we kept telling them it was going to have to stop, because they weren't pouring the concrete right. "You all don't know anything about it," he said...When we proved it to them on the spot, they stopped the job and did a bunch of core drillings. The core drillings were supposed to break at 2,000 pounds, or something like that. They couldn't even get the cores out in one piece—they just shattered. They stopped the whole thing and broke that contractor. But the Air Force did it.[310]

Fire Protection

Fire protection was critical to maintaining Air Force bases. Fire loss continually was monitored and improvements in fire protection to decrease losses were emphasized throughout the organization. During World War II, fire protection services were assigned to the post engineer. Army Air Forces Regulation 20-42 dated July 18, 1944 described the post engineer's responsibilities related to fire protection:

> Preparation of all plans for structural firefighting and prevention to insure [sic] technical sufficiency; the provision, training and supervision of necessary personnel pertinent thereto; the provision, maintenance, repair, and operations of structure firefighting and fire-prevention equipment, apparatus, sprinkler systems, and alarm systems; and the performance of other duties as more specifically defined by AAF Regulation 20-48. The post engineer is the base fire marshal.[311]

In January 1945, War Department Circular No. 36 transferred all crash rescue and firefighting activities and equipment from the Army Service Forces to the Army Air Forces. At Headquarters, Army Air Forces, fire protection was assigned to the Assistant Chief of Staff, Materiel and Services, Air Installations Division. On the base level, structural firefighting was under the post engineer, while aircraft crash rescue personnel reported to the aircraft maintenance officer. Aircraft rescue functions officially were consolidated with fire protection in September 1947 and both activities became the responsibility of the AIO, although both activities typically were conducted by the base firefighting staff.[312]

Firefighters prepare for action using their Model 125 vehicle.

The objective for base fire protection was to form a team of professionals who were constantly on alert to prevent fires, to control fires when started, and to undertake aircraft crash rescue operations.[313] During World War II, fire protection services expanded greatly as the number of bases increased. The potential for fire was a concern in light of the large number of temporary, wood-frame, mobilization buildings constructed during the war. The fire protection program at Langley AFB during World War II, for example, incorporated both prevention and operations. Prevention included distribution and inspection of fire extinguishers and automatic fire alarm systems, as well as on-going staff education to eliminate fire hazards. Firefighting operations were conducted from five stations. Firefighters had 14 pieces of equipment at their disposal, including a specially outfitted jeep and a 26-ton Cardox truck used for crash rescues.[314] Protein foam was used during aircraft crash rescues, while carbon dioxide foam and dry chemical agents were used in fighting structural fires. The typical crash kit in 1946 contained a rescue knife, sledge hammer, hunting knife, tinner's snips, cold chisel, gooseneck wrecking bar, offset wrecking bar, hack saw blades, hack saw, pipe cutters, wood and metal saw, bolt clipper, ball peen hammer, axe, and lineman's pliers.[315]

By 1948, the AIO duties related to fire protection were described as:

> Fire Protection and Aircraft-Crash-Rescue Activities to include discharge of duties and responsibilities of installation fire marshal as follows:
>
> Fire Prevention including development and supervision of fire prevention and protection standards, establishment and supervision of necessary fire prevention regulations; hazard inspections and fire and crash experience records.

<u>Fire Fighting and Crash Rescue</u> including operation of apparatus, equipment, and systems; operation and training of fire department personnel; and development supervision of firefighting and aircraft-crash-rescue methods.[316]

In 1948, the Fire Protection and Aircraft Crash Rescue Branch was a single department that oversaw the fire stations assigned to individual bases. By 1956, the Fire Protection and Aircraft Rescue Branch had evolved into five sections: Administrative Services, Fire Prevention and Protection Engineering, Operations, Training, and Maintenance. Individual fire stations located on the base were overseen by the Operations section.[317]

The organization was typically led by a civilian fire chief, who directed a staff of assistant chiefs and 40 to 60 personnel. Airmen were assigned primarily on those installations organized as Air Force combat wings, while civilians were retained on other types of installations. The mix of Airmen and civilians was dependent on the base. All fire department personnel were trained equally in fire prevention, structural fires, and appropriate crash and rescue procedures.[318] Staffing proved problematic during the early days of the Air Force. Airmen were not screened for firefighting duties and offered few incentives to join the field, since the top position of fire chief typically was held by a civilian. Most training for Airmen was provided on the job, although suggestions were made to send Airmen for formal firefighting training at Lowry AFB prior to their joining base firefighting stations.[319] In 1955, an on-the job training manual was issued to the firefighting community to increase functional knowledge in the field.[320]

Fires continued to present very real problems as Air Force operations expanded, resulting in loss of life and damage to facilities. Responses to this ever-present danger were pursued on several fronts and included increased fire prevention efforts, reduction of structural fire hazards through limitations on combustible and toxic building materials, installation of automatic sprinkler systems, and the introduction of new firefighting and crash rescue equipment.[321] Fire prevention efforts were publicized during annual national fire prevention weeks.[322]

The Air Force historically invested heavily in the best firefighting equipment and protective clothing. During FY48, $2.1 million was authorized for fire prevention and fire protection programs.[323] Research and development in the field was conducted at Wright-Patterson AFB, Ohio.

Members of the Tyndall AFB fire department pose with their vehicles, 1954.

One of the first trucks accepted by the Air Force was the O-10 Crash Truck. The O-10 was tested for operational suitability at the Air Proving Ground in early 1951 and the first trucks arrived at the installations by March 1951. By the end of the year, 65 trucks were delivered to the Air Force. One advantage of the O-10 truck was a turret capable of spraying different streams of foam agent. Another advantage of the model was that it was air transportable. In all, 1,058 Type O-10 crash trucks were manufactured, but the performance of these trucks was not satisfactory. The trucks were prone to numerous mechanical failures and replacement parts were unavailable.

A second crash truck, the type O-11A, was under development in 1951 and 1952. This truck was larger than the type O-10, carried 1,000 gallons of water, and was equipped to produce approximately 7,500 gallons of expanded fire-smothering foam. The agent was discharged through a system of remotely controlled turrets, ground sweeps, and hand line nozzles at a rate of 3,750 gallons per minute. The truck had a gross weight of over 40,000 pounds and could be transported by air in the giant C-124 Globemaster.[324] After several months of delays, the type O-11A crash truck was accepted and 890 trucks were manufactured for the Air Force. This truck also required high maintenance costs.[325]

At approximately the same time, the 530A and the 750 fire trucks entered the Air Force inventory. These trucks were used to fight structural fires. During 1952, Class 500 and 750 fire trucks had undergone acceptance tests and were scheduled for production. Twenty-five 530A trucks were delivered for use in the first year. The 530 and 750 fire trucks remained the primary structural firefighting vehicles for the Air Force until the early 1970s.[326]

Aircraft firefighting and rescue practices were complex operations due to the increasing intensity of flying operations and concentrated mass parking, fueling, and servicing activities. New aircraft technologies, including the introduction of the aircraft ejection seat system and new nuclear aircraft weapons, posed new challenges to firefighters. In addition, firefighters were charged with the protection of new classes of facilities, such as missile sites and communications facilities.[327]

By the late 1950s, several new initiatives were underway. The Air Force planned for the next generation of firefighter vehicles and equipment anticipated in the early 1960s. A new Airman firefighting

The 0-11A fire truck.

career field was established in fire protection to elevate the career field to a higher level of skill and prestige.[328] In 1957, the Air Force initiated the development of a helicopter designed to support fire suppression and rescue. The helicopter was part of an airborne fire suppression program known as PEDRO for the HH43 PEDRO helicopter model. The goal of the airborne fire suppression program was early arrival at remote crash sites and suppression of fire to enable personnel rescues.[329]

Utilities

The 1950s witnessed a dramatic rise in the level of use and costs associated with utilities, especially electricity. Utilities, including electric, water, sewage, gas, refrigeration, and steam services, were a major area of responsibility of the installations engineers. Often this duty entailed negotiating contracts from commercial companies as well as operating base utility plants. Utilities were overseen by the Utilities Operation Branch. This branch was divided into three sections: Custodial Services, Mechanical and Electrical, and Sanitary. The Mechanical and Electrical Section oversaw electrical power, natural or manufactured gas, heating, air conditioning and refrigeration, and utility fuel distribution. The Sanitary Section oversaw water supply, sewerage disposal, refuse collection and disposal, and insect and rodent control. By 1956, the organization was renamed the Utilities and Services Branch and comprised the following sections: Water Plant and System, Sewage Plant and System, Heating Plant and System, Power Plant and System, Insect and Rodent Control, Custodial Services, and Refuse Collection and Disposal.[330]

The increased number of Air Force installations with larger numbers of facilities and family housing was accompanied by increased demand for utilities. Electricity use skyrocketed to accommodate facilities requiring stringent temperature control and uninterrupted power. Power to sensitive warning systems was assured through backup power generations, which served as failsafe measures for primary power supplies. Air conditioning became a necessity with the introduction of heat-generating electronic systems. In addition, the Air Force regulations now allowed for the widespread use of air conditioning in both operations facilities and family housing.[331] The rise in energy consumption was dramatic during the decade. Between 1950 and 1958, air conditioning consumption rose from 95,000 to 240,000 horsepower; heating consumption rose from 400,000 to 1.8 million horsepower.[332]

In 1958, the Air Force utility bill for electricity, water, gas and sewage services was $60 million. Because of the completion of Capehart family housing, SAGE, and other missile programs, the Air Force's annual expense for purchased utilities grew to $90 million in FY60. During the 1950s, the Air Force gained the responsibility to negotiate utility contracts; earlier utility contracts were negotiated through the U.S. Army Corps of Engineers as the Air Force construction agent. The negotiations typically were conducted on the installation level, where the installations engineer was responsible for determining service requirements, checking the adequacy of supplier's power plants, providing technical assistance in the negotiating process, and approving the reasonableness of rates and connection charges. Assistance for these activities was available through the major commands and the Directorate of Installations at the Pentagon. Annual review of utility contracts became a new responsibility for the base installations engineer.[333]

By the end of the 1950s, the aging base utilities systems required modernization. Maintenance of the World War II systems was increasingly costly and was undertaken through individual maintenance and repair projects. Expenditures of P-400 Repair, Rehabilitation and Modification funds for utilities were rising and needed containment. In 1959, the major commands surveyed their bases for a proposed utilities modernization program. From this review, it was determined that $4.5 million were required to upgrade utility systems.[334]

Base Recovery

By the end of the 1950s, the installations engineers focused attention on the development of base recovery plans for CONUS bases. The 1956 AFR 20-42A contained the following directive on the installations engineer's role in base recovery:

> The installations engineer will provide shelter, demolition, area decontamination, damage control, disaster firefighting and rescue, emergency repair, and ultimate restoration of installation real property subject to damage or destruction by enemy attack and other disaster.[335]

The base recovery plan effort was advanced through a Headquarters U.S. Air Force letter dated October 31, 1956 regarding the "Assignment of Additional Function of Bomb Damage Repair to Installations Unit Mission." The topic of emergency repairs also was included on the agenda of the October 1956 installations command conference.

The Air Staff supported authorizing CONUS installations engineers with directing all base construction and repairs during emergencies. The installations engineer utilized military personnel from the base, military personnel from other active air bases, base civilian personnel, civilian contractors, and Reserve and Air National Guard units in this effort. Assigning Reserve personnel to installation damage control units also justified retention of Air Force personnel trained in minor construction and repair functions to support projected war plans.[336]

Recovery following a nuclear attack was an important aspect of the late 1950s base plans. A direct attack would destroy a base completely. A "near miss" scenario, however, required plans for emergency repairs to critical facilities and to counter radioactive fallout. Base recovery procedures also were necessary for installations possessing aircraft outfitted with nuclear weapons to address the potential for accidents. By the late 1950s, manuals, letters, briefings, and reference materials were available to installations engineers on base recovery planning after attack and other disasters.[337]

Early Community Relations

The proximity of civilian populations to Air Force bases became a source of concern during the early 1950s. The increasing noise levels generated by jet aircraft and the hazard posed by an aircraft emergency attracted the attention of the Air Force and surrounding communities. By 1953, property owners adjoining Hunter AFB, Georgia, filed a lawsuit contending that the operation of noisy jet aircraft caused great annoyance and property damage. Noise problems were related to jet aircraft taking off at low altitudes over populated areas. As early as 1951, Air Staff personnel began to monitor noise levels, to collect data to quantify noise hazards created by jet engine aircraft, and to develop strategies to reduce the problem. In 1954, the Air Force adopted a policy requiring a buffer zone between base housing areas and the flight line. This policy typically increased the acreage required for existing air bases.[338]

The Air Force also formulated plans for clear zones, and approach and takeoff corridors. Clear zones were spatial buffers at the ends of runways that provided room to maneuver safely in the event of aircraft failure during takeoff or landing. The addition of clear zones was problematic at bases where existing runways terminated at property lines shared by the Air Force and civilian communities. Approach and takeoff corridors addressed the air space surrounding air bases. These corridors extended over the surrounding communities and typically were defined as four miles wide by seven miles long. The surrounding communities were informed to expect aircraft noise in these corridors and to limit possible obstructions to the air space. For these reasons, the Air Force subsequently adopted the policy to establish new air bases 15 miles from the nearest major community.[339]

In 1955, the U.S. Congress House of Representatives Appropriations Committee directed that DoD conduct a thorough study of the problems related to operating air bases in proximity to populated areas prior to congressional consideration of the FY56 MCP. The Secretary of the Air Force appointed a committee of general officers chaired by Maj. Gen. Herbert B. Thatcher to investigate the current situation, to develop long term projections, and to identify the problems associated with air base operation in populated areas. The committee's report, entitled *Report of Air Base Bases and Civil Airports to the House Appropriations Committee,* documented the problems of noise and the potential hazards posed by aircraft accidents, as well as identified measures to minimize those problems. These measures included the reorientation of runways, relocation of bases, and changes in base missions, where feasible. The Air Force also worked with architect-engineer firms to reduce noise levels at selected critical facilities. By 1956, the Air Force had introduced a soundproof structure for semi-portable jet engine test stands. The structure was developed by AMC and was available beginning with the FY57 MCP. Design guidance and directives to control noise were issued. As a result of the study, the Air Force committed to the following actions: review of operational procedures to ensure that only the dictates of a vital mission overrode public interest and convenience; improvement of community relations by addressing the concerns of affected communities through publicizing precautionary measures adopted; and, establishment of outreach programs to explain the requirements of national defense and to raise public understanding of the valid reasons underlying the existence and the deployment of the Air Force.[340]

EDUCATION AND TRAINING

Air Force Institute of Technology (AFIT)

When the Air Force was created as a separate branch of the military in 1947, the former Army Air Force Institute of Technology was re-designated the Air Force Institute of Technology (AFIT) under AMC. AFIT, located at Wilbur Wright Field outside of Dayton, Ohio, was renamed the United States Air Force Institute of Technology (AFIT) in 1948. During this period, Wright-Patterson AFB was created through consolidating Wilbur Wright Field and Patterson Field.[341]

In 1948, AFIT was granted permission to institute the Air Installations Engineering Special Staff Officer Course and the Air Installations School. The first Air Installations Engineering Special Staff Officer Course began in spring 1948 and graduated 31 students in May 1948. The students ranged in rank from first lieutenant to lieutenant colonel; 22 were members of the Air Force and nine were from the U.S. Army Corps of Engineers. At the close of the following year, 326 pupils had completed the 12-week class.[342]

Coursework for the Air Installations Engineering Special Staff Officer Course included topics relevant to the duties of an AIO, including buildings and structures, master planning, cost accounting, property and supply, and preventive maintenance. In addition to classroom sessions, students were exposed to the realities of base maintenance shops and AIO organizations through field trips. A college degree originally was not required to enroll in the course, but previous college coursework was a prerequisite. The course of study was extended to 20 weeks in 1950. The prerequisites for admittance to the course also were raised to a bachelor degree in a related field, such as "city planning, architecture, architectural, civil, mechanical, or electrical engineering or industrial management." Experience in the civilian workforce could be substituted for academic achievements. In many cases, the educational requirements were waived.[343]

In 1950, AFIT was transferred from AMC to Air University, which had been created in 1946. In 1951, the Air Installations School was renamed the Installations Engineering Staff School and later became the Installations Engineering School. The first Advanced Engineering Management Class of eight officers was enrolled that same year. In 1953, the 20-week Air Installations Engineering Special

Staff Officer Course was replaced with two courses—an eight-week basic course and a 20-week advanced course. The basic course, which was later extended to nine weeks, was geared to officers who were new to the Installations Engineering Occupational Field; the basic course also provided a review and update for active duty officers who had completed engineering assignments on air bases. The curriculum was described as "devoted primarily to the administrative and managerial responsibilities of the installations engineer."[344] The length of this course and whether its principle audience of new second lieutenants should attend the course before being assigned to a base was hotly debated. Installations engineers contended that time spent in base organizations without the management knowledge acquired in the Basic Course was essentially wasted and required excessive, inefficient time in on-the-job training. AFIT countered that the last thing of interest to newly graduated engineers who had focused on design, was to learn about process and formality of project approval or maintenance and repair rules and regulations. The arguments waged on with sound reasoning on both sides.

The advanced course built upon the instruction of the basic course and was designed to enhance the skills of practiced installations engineers. The course description maintained that, "in addition to the subjects of administration and management, considerable emphasis is given to increasing the knowledge of the student in the fundamentals of electrical, civil, mechanical, and other fields of engineering with which the installations engineer is concerned in his work."[345] By 1956, 623 students were graduated from the basic course and 173 students were graduated from the advanced course. In 1956, the advanced course was extended to 37 weeks of study. The curriculum of the 21-week course was maintained with added emphasis on "management subjects and the solution of practical installations engineering problems."[346]

In 1954, President Eisenhower signed a Senate bill allowing AFIT to grant academic degrees. By 1955, AFIT was renamed, Institute of Technology; the following year, the institute granted its first degrees.[347] In fall 1958, Gen. Curtis LeMay, who then served as the Air Force Vice Chief of Staff, contacted each major command for assistance in identifying officers who met the criteria for admission to AFIT. General LeMay directed commanders to urge strongly those qualified to apply for enrollment. The number of applicants increased, but not to the desired level of 5,000.[348]

An early class of AFIT's Air Installations Engineering students, 1948.

During this same period, AFIT commander Maj. Gen. Cecil Combs advocated for new facilities for the school. The existing buildings, many of which were considered inadequate, were spread across the installation causing logistical and efficiency issues. In response to a request for construction funding for the school, Congress suggested that AFIT relocate to a base with adequate facilities. AFIT already had completed an analysis of other possible locations and determined that Wright-Patterson AFB was the appropriate location. Funding for new buildings was not immediately forthcoming.[349]

Department of Civil Engineering Training, Sheppard Air Force Base, Texas

When the Air Force was created in 1947, the Air Training Command (ATC) operated at 13 installations and included 49,321 personnel. Headquartered at Barksdale AFB in Louisiana, ATC provided training through three divisions: Flying Division, with seven units; Technical Division, with five units; and Indoctrination Division, with one unit. In 1947, a budget decrease led to the elimination of some of its civilian instructors. This reduction in force impacted the quality and scope of technical training courses.[350]

In 1947, ATC initiated generalized technical training where instructors used basic machinery in their curricula. Advanced training was gained on the job. In September 1947, the premier course was offered in airplane and engine repairs. Other training offered by ATC included aviation career planning, a course offered to high school graduates who planned to join the service. Jet fighter training, basic flying training, fighter gunnery training, and flight engineer training also were offered through the command. ATC also was responsible for instructional materials that were circulated to various Air Force offices.[351]

Geiger Field, located near Spokane, Washington was used by ATC as an Aviation Engineer Training Center as early as 1947. In spring 1947, Headquarters, U.S. Air Force transferred training from Geiger Field to Fort Francis E. Warren, located in Wyoming. Training activities were reactivated at the new location by June 1947. ATC began using Sheppard AFB, Texas, for various technical training in February 1949. Civil engineering technical training was relocated to Sheppard AFB in 1957. The Department of Civil Engineering Training was organized by ATC at Sheppard AFB in July 1958.[352] The department operated from a single building and began with a course in utilities.[353]

Fire Training

During World War II, formal firefighting training was established by the Army Air Forces. In 1943, the first firefighting school was established at Geiger Field, Washington. The following year, the firefighter school was relocated to Buckley Field, Denver, Colorado. In 1946, the school moved to Lowry AFB a few miles away from Buckley Field. Chief Jasper W. Patterson led the majority of classes and instruction at Lowry AFB. Training under Chief Patterson focused on field training with 80 percent of instruction occurring in live demonstrations and practices.[354]

Throughout the 1950s, the basic firefighting and advanced training courses were revised continually to meet modern needs. Special structural training facilities were introduced at Lowry AFB to teach structural firefighting techniques in a realistic environment. A training film about aircraft firefighting and rescue techniques was completed and a comprehensive handbook and chart series on the features of all first-line aircraft to support to effective firefighting was nearing completion. Data were automatically revised in coordination with aircraft procurement and modification programs.[355]

THE ISSUE OF TROOP CONSTRUCTION

The U.S. Army Corps of Engineers initially retained the responsibility of providing troops to undertake Air Force construction for overseas contingency and wartime situations. The Engineer Aviation Battalions formed by the U.S. Army Corps of Engineers during World War II had performed

In October 1952, a SCARWAF shoulder insignia was officially established.

well in a variety of challenging situations. The U.S. Army Corps of Engineers argued effectively that it retained the capability to continue to provide services to both the Army and to the Air Force. Thus, the U.S. Army Corps of Engineers established the Special Category Army Personnel with Air Force (SCARWAF) to support Air Force contingency needs. Under SCARWAF, the Air Force furnished funding and manpower authorizations, while the Army recruited, organized, trained, and equipped the units prior to assignment to Air Force control.[356] SCARWAF units began working for the Air Force in both Europe and the Pacific in 1947. Lt. John D. Peters served in four SCARWAF units between 1947 and 1949 while on assignment in the Pacific. He ended up working in a SCARWAF unit assigned to Harmon Field, a large depot, on Guam.[357]

Not all Air Force personnel were pleased with the new arrangement. A lesson learned by the Air Force during World War II was that airfields were most effectively built by construction troops under Air Force control. Nevertheless, the Directorate of Installations worked closely with the U.S. Army Corps of Engineers to ensure that the Air Force got the support that it needed. Brig. Gen. Oran Price, a veteran World War II engineer who transferred to the Air Force in 1947 and worked at Headquarters U.S. Air Force from 1946 to 1949, summarized the situation: "There were a whole lot of us that were disturbed when we started losing that warfighting capability after World War II. There was a lot of pressure to civilianize, a lot of pressure to contract, and we simply could not convince the manpower people to give us the slots for any kind of units that might be capable of operating in the field and operating on their own. We fought a losing battle on that score over the years."[358] The Air Force submitted a proposal to the Secretary of Defense in fall 1949 to transfer the aviation engineer units to the Air Force. The Secretary of Defense rejected the proposal in spring 1950.[359]

For the first year or so, SCARWAF aviation engineer units worked under the direction of the Air Engineer at Headquarters U.S. Air Force. The Air Engineer was a U.S. Army Corps of Engineers officer who reported to the Air Force Chief of Staff on all matters pertaining to SCARWAF units, including engineer planning related to Air Force air war plans. Brig. Gen. Samuel D. Sturgis, Jr., served in that capacity from 1946 to 1948. His job as the Air Engineer was to ensure that there was "available to the Air Force an adequate Aviation Engineer component organized, manned, equipped, and trained so that, in the event of hostilities, this construction force [could] be promptly deployed and [could] effectively accomplish the aviation engineer mission."[360]

Under the March 19, 1950 reorganization of the Directorate of Installations, all responsibilities formerly performed by the Air Engineer were vested in the Troops Division of the directorate. Although the staff in the Troops Division likely worked with a liaison at the U.S. Army Corps of Engineers, the list of duties reassigned to the Troops Division was comprehensive and mirrored the responsibilities previously assigned to the Air Engineer:

Role in Berlin Airlift, June 1948 to May 1949

In June 1948, the U.S.S.R. halted ground access to West Berlin, stranding military contingents from the U.S., England, and France. Two million German citizens were left without access to food, fuel, and other vital supplies. In response, British and U.S. forces initiated an airlift of an estimated 4,500 tons of supplies per day to the city. The work horses of the airlift were the 3-ton capacity C-47 and the 10-ton capacity C-54 aircraft. These aircraft flew from four airfields outside the U.S.S.R. zone through two, in-coming air corridors to West Berlin. West Berlin had two airfields, but only one usable runway, which was constructed by aviation engineers after the end of the war.

Aviation engineers from the U.S. Army Corps of Engineers worked closely with the U.S. Air Forces in Europe (USAFE). The aviation engineers were vital in the construction and maintenance of airfields in West Berlin and the airfields from which supplies were airlifted. Lt. Gen. Curtis LeMay, the USAFE commander, mandated that airstrips remain operable. Between flights, engineers and crews patched the runways to keep aircraft flying. Aviation engineers organized work crews who swarmed onto the runway after a plane touched down and quickly repaired the PSP mats. The engineers then raced off the runway to avoid the next incoming aircraft. Additional runways were needed in West Berlin, so a second runway was completed at Templehof between July and September 1948. New runways also were completed at a third airfield at Tegel in December 1948 and March 1949. Heavy construction equipment needed for runway construction was not available in Berlin and was flown in from the Army Engineer depot at Hanau near Kaiserslautern. Approximately 40 pieces of heavy equipment, including rollers, graders, bulldozers, and scoop-type carryalls, were disassembled or cut apart to fit into cargo bays, flown to Berlin, and reassembled. Two complete rock crushing and screening plants also were transported. From June 24, 1948 through September 30, 1949, U.S. and British aircraft delivered over 2.3 million tons of cargo to West Berlin in almost 300,000 flights.[361]

Col. (later Brig. Gen.) William Leonhard was serving with the U.S. Army Corps of Engineers as the Director of Installations for USAFE and stationed at Wiesbaden. General Leonhard recalled supporting the Berlin Airlift: "We built two new runways at Rhein-Main, an extension at Wiesbaden Air Base, opened two bases in the British Zone at Fosburg and Celle, two new runways at Templehof in Berlin and built a new International Airport at Tegel in the French Sector of Berlin. It was a very exciting year or more." During that time, General Leonhard transferred from the U.S. Army Corps of Engineers to the Air Force.[362]

While the new runways were built, the old ones had to be repaired. Workers repair the runway at Tempelhof using hand tools.

- Monitor the flow of officers and enlisted men to and from engineer aviation units,
- Handle training of engineer aviation units and procurement of tables of operations and equipment,
- Establish policies and procedures for all matters pertaining to use and equipping of engineer aviation units [as well as installations squadrons],
- Develop the Directorate of Installations portions of war and mobilization plans,
- Develop construction materials requirements in support of the Air Force Mobilization Plan, and
- Arrange field tests of equipment at Eglin AFB, under the 809th Engineer Aviation Battalion.[363]

The Troops Division remained in control of SCARWAF units until mid-1951, when another headquarters reorganization split the division and moved responsibility for SCARWAF to the Aviation Engineer Office. In late 1951, the Aviation Engineer Office was realigned directly under the DCS for Operations (DO), rather than under the Directorate of Installations. From that time forward, the DO took responsibility for activating, manning, equipping, training, and deploying SCARWAF units, while the Installations Directorate played a supporting role by establishing standards and criteria, developing materials and equipment, and making recommendations with regard to organization, manning, equipping, and training.[364]

The Army did its best to organize and train SCARWAF units and to assign them to the Air Force, but battalions were utterly dependent on equipment to perform their mission. By 1950, the Air Force was responsible for equipping units. Administrative delays in budgeting, placing orders, and getting equipment delivered meant that SCARWAF units were not combat ready for deployment, or even properly trained, until the equipment was available. To address this situation, the Troops Division changed the precedence status of some units and adjusted the length of training for others. The Air Force also centralized control of all SCARWAF units under one command—Continental Air Command (ConAC). ConAC then developed one single regulation that governed the employment of SCARWAF units on major Air Force construction and rehabilitation projects.[365]

The majority of peacetime SCARWAF construction projects on air bases were conducted in remote locations, such as Alaska; the Air Force Missile Test Range in the British West Indies; and, at air control and warning sites in northern Canada for Northeast Air Command. Those jobs were conducive to unit training under different climatic conditions and accomplished significant, cost-effective work for the Air Force.[366] During summer and fall 1947, two engineer aviation battalions deployed to bases in Greenland and on Baffin Island off of Labrador, Canada, to rehabilitate five bases that had fallen into serious disrepair since the end of World War II, but that the Air Force needed to keep open for strategic reasons. At Bluie West 1, Bluie West 8, Crystal I, II, and III, the aviation engineers, reinforced by a team of 105 civilian specialists, rehabilitated airfield pavements and roads; repaired electrical, plumbing, and heating systems; installed water tanks and distribution systems; erected a new crash fire station at one site; and, rehabilitated a large hangar at another. In 1949, the 806th Engineer Aviation Battalion completed yet more construction and rehabilitation projects at bases in the North Atlantic. In 1949, aviation engineers also assisted in the phase down of three Caribbean Air Command bases—Atkinson, Beane, and Coolidge AFBs—that were scheduled to be returned to the British.[367]

SCARWAF troops were also employed in Europe to accommodate the dramatic increase in troop deployments as part of U.S. support to NATO. In Germany, 7th Army was activated in early fall 1950, with headquarters at Stuttgart-Vaihingen. It became the first fully operational field army to exist in Germany since February 1947. On February 24, 1951, the 7th Engineer Brigade was organized and redesignated as the 7th Engineer Aviation Brigade and was designated as a SCARWAF unit. Stationed at Rhein-Main AB near Frankfurt, the 35,000 troops of the brigade assumed responsibility for all aviation construction in Italy, France, and Germany. To accomplish construction in France in June 1952, Continental Air Command reassigned two engineer aviation groups with subordinate battalions to Headquarters, USAFE: the 322d Engineer Aviation Group (EAG) stationed at Toul-Rosiéres AB and the 924th EAG at Bordeaux AB. Other SCARWAF engineer aviation battalions performed air base construction and renovation in the United Kingdom. In late 1949, a SCARWAF construction force comprising one engineer aviation group, three battalions, a maintenance company, and a depot company deployed to rehabilitate four medium bomber bases in the U.K.[368]

Despite the valuable work performed by engineer aviation battalions, both Army and Air Force engineers recognized that split responsibility for the SCARWAF program was a source of difficulties. Most complaints were voiced on the Air Force side. While the Air Force officially controlled the units assigned to it, the Air Force had little control over the selection of SCARWAF personnel or the quality of their training. Adequate funding and timely procurement and delivery of equipment for SCARWAF units exacerbated the situation. Those issues, although not critical in peacetime, had real mission impacts during wartime operations.

In addition, the U.S. Army Corps of Engineers acknowledged that it was falling behind in its efforts to balance the aircraft design and base construction necessary for any future overseas conflicts. The runways built by aviation combat engineers during World War II were, by 1948, insufficient to support long-range bombers at intermediate bases overseas or in inhospitable areas, such as Alaska and northern Canada. In addition, the Air Force's increasingly heavy aircraft and swift jet aircraft required thicker and longer runways. These runways took longer to build and surpassed what was feasible in terms of time and materials for troop construction at intermediate bases in forward combat situations.[369]

The Korean Conflict

The first wartime mission of the independent Air Force was the Korean Conflict between 1950 and 1953. Korea, which had been part of the Japanese empire since 1910, was jointly occupied by troops from the U.S.S.R. and the United States after World War II. The U.S.S.R. troops occupied the northern half (above the 38th parallel) of the peninsula, while U.S. forces occupied the southern half. The 38th parallel split the Korean peninsula in half and served as the line of demarcation until elections could be held and occupying forces withdrawn.[370] It was anticipated that a new government would unify the peninsula.

Although occupying forces left the Korean peninsula in 1948 and 1949, peninsula-wide elections did not take place. United Nations-sanctioned elections were held in the Republic of Korea (South Korea); the Democratic Republic of Korea (North Korea), which was supported by the U.S.S.R., did not hold elections. Each government claimed legitimacy and threatened to cross the 38th parallel. However, neither government could act without assistance from its respective supporters.[371]

Tensions culminated when the North Koreans took decisive military action against the South. With U.S.S.R. approval, the North Koreans crossed the 38th parallel on June 25, 1950. The United Nations (UN), with the support of the United States, came to the aid of the South Korean government. The hostilities on the Korean peninsula represented the first time that the recently-created UN intervened in military action. The U.S.S.R., boycotting the UN for its failure to recognize the People's Republic of China, was absent from the Security Council during the vote to commit troops to South Korea.

The Korean Conflict presented several challenges to Air Force personnel. Whereas Air Force flying units were operational from the first day of the conflict, engineering services were not available to support the flying mission. Indeed, lack of trained aviation engineer support proved detrimental to Air Force operations. As summed up by Air Force historian Robert Futrell, "In two years of war in Korea no single factor had so seriously handicapped the Fifth Air Force operational capabilities as the lack of adequate air facilities."[372]

At the start of the conflict, Air Force civil engineers initially were ordered to construct six airfields in South Korea. The construction task was turned over to SCARWAF units. In June 1950, SCARWAF was undermanned with 3,500 authorized and only 2,322 personnel assigned to the Far East Air Forces. These SCARWAF units comprised two Engineer Aviation Groups (EAG), the 930th and the 931st, stationed in Japan; five Engineer Aviation Battalions, including the 811th in Guam, and the 839th, 802d, 808th, and 822d in Okinawa, Japan; and, one Engineer Aviation Maintenance Company, the 919th in Japan.[373] In total, the available personnel were only 80 percent of the strength allowed during peacetime. They were only 46 percent of the strength allowed during wartime. Even more staggering, commanders of the 930th and the 931st EAGs assessed their troops to be 10 to 15 percent as efficient as they were during World War II.[374]

The first SCARWAF unit to arrive in South Korea was the 802d Engineer Aviation Battalion Company A. This unit traveled by ship from Okinawa and landed on the beach at Pohang in July 1950.[375] Since the 802d was the first engineer unit assigned to South Korea, personnel were forced to contend with a lack of airfield facilities. They also faced the daunting task of utilizing equipment leftover from World War II with few spare parts available.[376]

List of Major Equipment Items per SCARWAF brigade, 1951[377]

1	Earth auger	1	Quarry set
3	Air compressors, 315 CFM	3	Road rollers, 10 tons
3	Air compressors, 105 CFM	1	Road roller, 8 tons
1	Crane, 20 ton	1	Road roller, 50 tons
8	Crane-shovels	3	Sheepsfoot rollers
1	Crushing and screening plant	1	Road rooter
2	Asphalt distributors, 800 gallons	18	Road scrapers
6	Water distributors, 1,000 gallons	3	Motorized shops
1	Ditching machine	4	Aggregate spreaders
4	Electric sets, 5 kW	4	Rotary sweepers
1	Electric set, 15 kW	16	Crawler tractors
9	Motorized road graders	22	Wheel tractors
1	Towed road grader	34	Trucks, ¼ ton
2	Asphalt heaters, 42 HP	18	Trucks, ¾ ton
3	Asphalt repair kettles, 165 gallons	27	Trucks, 2 and one half ton
4	Lubricators	54	Dump trucks, 5 tons
2	Concrete mixers, 16 cubic ft	14	Truck tractors, 6 tons
1	Rotary till soil stabilization mixer	4	Truck tractors, 12 tons

Company A of the 802d was assigned the duty of renovating the Pohang airfield to accommodate fighter airplanes. The unit was small and undertrained, and equipment was scarce. As a result, portions of the four Engineer Aviation Battalions located in Okinawa were relocated to Pohang to provide assistance. The company enlarged the existing runway by 500 feet using pierced-steel plank (PSP) and installed a taxiway stretching 40 feet in width with 27 hardstands. By August 1950, the company was required to abandon its construction mission and to defend the airfield against the North Koreans. Eventually, Company A was honored by the Far East Air Force with a Distinguished Unit Citation for its work as builders and also as infantry personnel.[378]

Initially, SCARWAF engineers focused on upgrading South Korean and Japanese World War II bases using expedient measures. The first units to arrive were often surprised by the condition of pre-existing South Korean airfields, such as the airfields at K-1 (Pusan West) and K-2 (Taegu). K-1's airfield was nearly level with the surrounding flooded rice paddies and lacked a cantonment area; K-2's

Members of the 808th Engineer Aviation Battalion transform a rice paddy into an airstrip in Korea.

airfield was originally a 3,800-foot long sod runway with gravel and had been used by the Japanese during World War II.[379] Only two South Korean airfields could accommodate high-performance aircraft: K-13 (Suwon) and K-14 (Kimpo). K-14 (Kimpo) had been improved by U.S. troops at the end of World War II, and was South Korea's most modern airfield.[380] As heavier and larger aircraft utilized these bases, the runways quickly deteriorated through constant use. World War II runways were built to withstand 80 psi, yet the newer aircraft required 200 psi.[381]

The Korean terrain provided difficult obstacles to overcome. The mountainous topography considerably narrowed the selection of suitable land for new airfields. Appropriate lands were often terraced by farmers and continually flooded to propagate rice. The poor drainage and high water table combined with seasonal monsoons caused numerous delays in construction. Proper runway construction oftentimes required excavating the rice paddy soil to a depth of up to 15 feet.[382] Heavy construction equipment was easily mired in the water-logged land.[383] The Korean winters presented additional challenges to engineers. At K-6 (Pyontaek) engineers of the 1903d Engineer Aviation Battalion worked in 12 degree F temperatures during winter 1952. The 1903d was forced to ignite four 100 lb. charges of dynamite to clear the frozen rice paddy which comprised a depth of 10 feet and an additional 15 feet of peat.[384]

While PSP was an expedient material, it did not hold up under constant use by a wide variety of aircraft. It buckled under the wheels of heavy aircraft, creating rough runways and tire hazards.[385] Nevertheless, PSP was indispensable. Only a few months into the war, by December 1950, an estimated 8.3 million square feet of PSP was installed in South Korea and Japan; another 10 million had been requested by the Far East Air Force.[386] The majority of construction problems that occurred with PSP runways, taxiways, and aprons were related to improper subbase preparation prior to laying PSP. In many instances, the matting was laid directly upon the ground. The underlying subbases were susceptible to erosion by oil spills and jet blasts, causing an uneven operating surface. One C-45 aircraft had nine false starts at Taegu AB during a safety test due to the PSP runway conditions. Not only was it difficult for aircraft to land and take off, but damaged matting sliced tires and damaged aircraft engines. PSP maintenance required routine straightening of individual planks; replacing clips; welding breaks in the matting; and, patching the subbase.[387] Until construction directives were in place, engineers attempted to remedy the problems by several different means. Rice straw bags or burlap bags were layered on the subbase beneath the PSP as a way to avoid soil erosion; in other instances, the ground was asphalted and then laid with PSP.[388] By May 1951, the Air Force decided that building permanent concrete runways at large bases was more cost effective than maintaining PSP runways.[389]

Development of Aircraft Arresting Systems

The aircraft arresting system for Air Force aircraft was introduced during the Korean Conflict. This system was adapted from the Navy's aircraft carrier system.

World War II-era runways were employed in-country during the Korean Conflict. The aircraft of the period, however, were heavier than that flown in the earlier war and required longer runways. As a result, aircraft over-runs of the 1940s runways were common. Even the construction of longer, 9,000 foot runways did not address adequately the over-run problem for more powerful aircraft, such as the F-86 Sabre. Installation of an aircraft arresting system was identified as the solution to the problem.

The first arresting system developed by the Air Force was MA-1A.[390] The MA-1A employed nylon webbing, which was stretched across the runway and anchored to heavy chains. Aircraft hit the webbing and were halted by the weight of the chains as they were dragged down the sides of the runway.[391] The major disadvantage to the system was the potential for aircraft damage from the impact with the web. Tests of the system were completed at Johnson Air Force Base, Japan, on March 21, 1953. MA-1A systems were installed at several South Korean air bases by May 1953.[392] A variation of the MA-1A included a steel cable supported by rubber disks running parallel to the web that arrested tail hook-equipped aircraft such as the Century Series of fighters. The MA-1A still remains in use at some installations as a back-up system.

As aircraft increased in size and speed, the chain system used in the MA-1A was not effective in stopping the planes. The Barrier Arresting Kit 6 (BAK-6), or "Water Squeezer," was designed to arrest aircraft with or without arresting hooks. The BAK-6 employed two tapered tubes filled with water. When the cable was engaged by the aircraft, a piston was pulled down the tube, and as the diameter decreased, hydraulic pressure slowed, and stopped the plane.[393]

In early 1959, the Air Force contracted with the All American Engineering Company to purchase 50 BAK-6 systems.[394] While the BAK-6 was one of the simplest and easiest to maintain arresting systems, it had drawbacks. After an arrest, five men and three vehicles returned the pistons to the original location. In freezing weather, the piston manually moved a few feet each day and the antifreeze level of the solution required frequent checking.[395]

The Air Force tests a MA-1A aircraft arresting system using an F-86 "Sabre" jet at a base in Japan. This system used heavy ship's anchor chain to slow down the aircraft.

The operation and maintenance of equipment assigned to SCARWAF battalions in South Korea also posed a major challenge. The overwhelming requirements for engineering capabilities in the early months of the war demanded the highest availability of training and equipment. Operators had little more than a two-week familiarization course in observing the operation of the equipment and were generally unqualified to operate it. High accident rates and vehicle abuse were common. A report analyzing SCARWAF support stated, "in-commission rates as low as 0-15 percent on critical items of equipment during peak operational periods were the rule rather than the exception." Depot overhaul was normally required after 5,000 operating hours, but SCARWAF equipment sometimes required it after fewer than 500 hours. Vehicle maintenance personnel had to work in mud and snow under extremely adverse conditions. In addition, SCARWAF units were plagued by the issue of non-standard equipment and a lack of spare parts, making maintenance problematic.[396]

An Airman repairs a runway light at a Korean air base.

With an Air Force Douglas C-124 "Globemaster" unloading its cargo, an aviation engineer on a heavy road grader repairs a runway at a base in Korea.

In addition to the task of runway construction, aviation engineers also constructed maintenance and support facilities and troop housing.[397] Installations squadron personnel also worked on these projects and the definition of construction activities became blurred under mission requirements. Air Force personnel were quartered in tent cities until the arrival of more permanent facilities such as Quonset huts, Tropical Shell kits, and stucco buildings. Tropical Shell kits were prefabricated wood frames covered with metal sheeting or wood shipped to South Korea from Japan and typically constructed by contracted labor overseen by installations squadron personnel.[398]

Installations squadron personnel also had the opportunity to test how their base-level skills fared when deployed to manage and maintain air bases in South Korea. Initial units were made up of individuals or small detachments comprising 10 to 25 Airmen from installations squadrons throughout the Far East Air Forces. These units were equipped with only the minimum hand tools, trucks, and crash-rescue and water purification equipment. Lack of equipment and spare parts hounded every deployed civil engineer. In many instances, installations squadron personnel worked alongside SCARWAF units to finish construction tasks. Then, they were faced with maintaining runways and, often, with completing extensive renovation and alteration of buildings and other facilities. Providing water and electric power proved to be the two biggest challenges, as well as finding and maintaining equipment. For example, Osan AB ran exclusively on generators. In addition, installations squadron personnel were responsible for conducting firefighting and crash rescue operations at the bases. Personnel shortages in installations squadrons were augmented through employing 300-400 South Koreans per installation and contracting local firms to complete many tasks.[399]

At the outset of the war, the Air Force air bases had no set guidelines for construction. The initial tasking for installations squadrons was "to repair and maintain buildings and grounds, operate and maintain base utilities, provide structural and crash fire protection, and provide maintenance on assigned ground powered equipment."[400] During September 1951, the Air Force wrote and distributed "Construction Criteria for Korean Theater of Operation Air Bases." With the new policy, the Air

As a B-26 light bomber taxis alongside, members of the 808th Aviation Engineer Battalion continue grading an airstrip to support air operations.

Force was now responsible for "the construction, reconstruction, rehabilitation," as well as repair and maintenance, of its air bases in South Korea.[401]

The Far East Air Force acquired additional SCARWAF units in 1951 and the amount of construction in South Korea grew. The following table (Table 2.4) lists some of the many projects completed by SCARWAF units during the Korean Conflict.[402]

A cease-fire to end the Korean Conflict was negotiated in July 1951; however, fighting did not end until July 1953 when China, the United States, and North and South Korea agreed to an armistice. The North Koreans, Chinese, and U.S.S.R. continued to refuse peninsula-wide elections. The conflict did not result in a clear victory for either the United States and its allies or the U.S.S.R. and its allies. The boundary between North and South Korea essentially was unchanged.[404]

By the end of the Korean Conflict, SCARWAF had constructed or renovated 55 airfields that supported the flights of 700,000 combat missions. At the close of the Korean Conflict in July 1953, the performance of SCARWAF was assessed. As a result, the Far East Air Force reported that "the Korean experience also demonstrated that the Air Force had a vital need for engineer aviation forces which were not combat engineers nor construction engineers but specialists in the art of building airfields… Absence of training on complex equipment and shortages of properly qualified engineer aviation personnel…were the principal causes of engineer aviation ineffectiveness in Korea."[405]

Lessons learned by the Air Force civil engineers were reminiscent of those learned during World War II. Among those important lessons were:

- Engineer aviation units needed to be integrated into the Air Force and be self-supporting in terms of wartime construction and maintenance abilities.
- Self-supporting units meant that they had to be adequately and realistically trained with appropriate skill sets and equipment with sufficient spare parts to do their jobs from day one in a contingency situation.
- Personnel had to be trained individually to do their jobs and to function as a cohesive unit. All personnel, from officers to Airmen, had to be experienced, flexible, and innovative to get their jobs done.

- New construction techniques and materials had to be developed to build runways and cantonments to keep pace with aircraft technology. The use of PSP for runways was no longer viable. New designs for supporting structures also were required.
- The use of local contractors and laborers was vital to constructing and maintaining airfields in contingency situations. Required skills for installations personnel included personnel management, oversight of work crews, and experience in contracting.[406]

Table 2.4 SCARWAF Units and Construction Projects During the Korean Conflict

Unit	SCARWAF Construction Projects
366th Engineer Aviation Battalion	Pusan East: constructed 6,015-foot paved runway and 300,000-square foot apron (67 days); covered runway in asphalt (30 days) Pusan: constructed 7,000-foot paved runway and renovated facilities (6 months)
802d Engineer Aviation Battalion	Pohang: constructed 3,300-foot PSP extension to existing runway (1,000 feet in 30 days); covered existing runway with asphalt
808th Engineer Aviation Battalion	Kunsan: constructed 9,000-foot asphalt runway; 42 hardstands (<4 months)
809th Engineer Aviation Battalion	Kunsan: assisted 808th with runway Chunchon: constructed 4,190-foot PSP runway and repaired existing runway (6 months) Hoengsong and Kangnung: repaired existing runways (30 days)
811th Engineer Aviation Battalion	Seoul: constructed 4,500-foot PSP runway and expanded it to 5,650 feet Kimpo: repaired existing runway; built 1,000-foot expansion to runway Kangnung, Suwon, Chunchon, Chugju, Hoengsong, Chinhae, Taegu, and Pusan: repaired and constructed runways and runway extensions
822d Engineer Aviation Battalion	Pusan East and Taegu: constructed PSP runways and extensions and maintained and replaced worn PSP (within 2 months had installed 67,000 square feet of PSP)
839th Engineer Aviation Battalion	Pyongtaek: constructed 4,950-foot runway with PSP Osan-ni: constructed new airfield with 9,000-foot concrete runway, 2 178,500 square foot aprons, 80 hardstands, warehouses, transportation network, and infrastructure
840th and 841st Engineer Aviation Battalions	Osan-ni: assisted 839th with new airfield construction
1903d Engineer Aviation Battalion	Pyongtaek: constructed 8,000-foot runway Pusan: repaired runway

Source: Lt. Col. Floyd Ashdown, "A History of the Warfighting Capability of Air Force Civil Engineering," Research Report, Air University, Maxwell AFB, Alabama, 1984, 25-28.

Aviation Engineer Force (AEF)

The intense pressures of the early months of the Korean Conflict quickly revealed the inadequate readiness of the initial SCARWAF battalions that deployed. SCARWAF units were undermanned, poorly equipped, and described as "totally untrained."[407] To remedy the situation in the short-term, the Air Force contracted with the Vinnell Corporation to provide personnel and equipment to augment SCARWAF troops in South Korea and to train them in construction methods and equipment maintenance. It was a stop-gap measure, at best, and contractors eventually ended up doing some of the construction work themselves.[408]

A more permanent solution was proposed in March 1951. Continental Air Command, which assumed responsibility for all stateside SCARWAF units in early 1951, activated a special headquarters-level unit known as the Aviation Engineer Force (AEF) at Wolters AFB, Texas, on April 10, 1951. Upon activation, 10 SCARWAF aviation engineer units were assigned to the AEF—one engineer aviation brigade, two engineer aviation groups, four battalions, and two maintenance companies. Thus, the AEF exercised centralized control over all aviation engineer units operating and training in CONUS. AEF's principal job was to train and equip SCARWAF units to ensure that they were ready for immediate deployment overseas, and to confirm that they were trained to the proper level of readiness to accomplish their construction missions.[409]

The AEF existed from 1951 to 1956. During that time, 57 SCARWAF units were assigned to it, of which 33 ultimately deployed overseas. Approximately 60,000 troops passed through the AEF during its five-year history, for an average turnover of 12,000 troops per year. The average strength of the AEF during that time was 10,593 troops, with an average construction force of 11 battalions.[410]

Col. (later Brig. Gen.) Herbert W. Ehrgott served as the first commander of the AEF from April 1951 to August 1953. The person who played a dominant role in operation of the AEF, however, was Col. (later Maj. Gen.) Guy H. Goddard, who served as the AEF Deputy Chief of Staff for Operations from November 1951 to June 1956. These officers faced a daunting task, but they were able to draw on their long experience with the U.S. Army Corps of Engineers and aviation engineer units to achieve notable results in a relatively short period of time.[411]

Prior to the establishment of the AEF, the Air Force had made arrangements to use the infantry training center at Fort Huachuca, Arizona, to train SCARWAF aviation engineers for the Korean Conflict. The Air Force took possession of the fort on February 1, 1951, making it the only active Army installation that had an existence, albeit for a very short time, as an Air Force base. Six weeks later, on March 15, control of the reservation transferred to the Sixth Army at the Presidio in San Francisco. In June 1951, under the auspices of the AEF, an Engineer Aviation Unit Training Center was established at the fort. Units that trained there in 1952 were the 45th, 304th, 327th, and 923d Engineer Aviation Groups and the 69th, 71st, 820th, and 844th Engineer Aviation Battalions. As part of their training, several units built Libby Army Airfield at Fort Huachuca. The AEF training center was inactivated by the end of the Korean Conflict.[412]

Once the AEF was established in April 1951, it organized extensive training programs both at its home station at Wolters AFB and at Beale AFB, California. The training program provided units experience in major air base construction projects to be performed by a deployed battalion. Trainees learned how to work together as a unit to organize and accomplish large projects ranging from bridges to airfields. They carved out hundreds of miles of roads and learned to create runways using pierced steel planking. Sometimes their training involved participating in disaster relief efforts, such as fighting forest fires, managing flood control, and conducting clean-up operations after tornados.[413]

One problem that plagued SCARWAF units was the fact that they were organized under the Department of the Army Tables of Organization and Equipment (TO&E), with little regard for the Air Force mode of operation. Training organized by the AEF gave units a good feel for the types of work that they would actually be performing once they deployed.[414]

The Aviation Engineer Force emblem.

Another problem that became immediately obvious was that the troops arriving for training had not received any significant level of individual training. From the very first, the Army was unable to provide qualified individuals to aviation engineer units. During the first six months of training operations, AEF officials ascertained that only 28 percent of incoming SCARWAF troops had the proper Military Occupational Specialty (MOS) training. A later survey disclosed that only 23.8 percent of SCARWAF personnel assigned had been school trained, and that 82.4 percent had less than five months of experience in their primary MOS. To complicate the situation, the AEF received very few quotas to send personnel to attend Air Force schools to make up the difference.[415]

Because the operational readiness of units depended greatly on the quality of individual training, the AEF realized it had to provide individual specialist training to bring units up to speed. Unfortunately, the mission and organization of the AEF was set up to accommodate unit training, rather than individual training, so Colonel Goddard and his staff had to change gears quickly. They persuaded Air Training Command to expand its technical training at F.E. Warren AFB, Wyoming, to include such courses as woodworker, powerman, water supply and sanitation technician, and heating specialist.[416]

As time passed, emphasis on formal training decreased and greater emphasis was placed on on-the-job (OJT) training. At first the OJT program primarily augmented the formal school program, but ultimately the AEF staff realized the importance of institutionalizing the program. It developed and published a series of 90 different MOS course outlines and guides and made the OJT program an organic part of the training process. Staff members also recognized the importance of validating the progress that individual troops were making and developed an intensive program of proficiency testing.[417]

The AEF staff slowly but surely strengthened the criteria for relevant unit training. AFR 50-20, “Aviation Engineer Training,” written in 1950, stated that the primary mission of SCARWAF units was to maintain a status of training to “ensure an aviation engineer force capable of acceptable early mobilization employment.” It noted, however, that training could, as a by-product, contribute to peacetime construction, repair, and maintenance operations. The idea was to accomplish two objectives with one action: to use construction troops on large, meaningful projects for the security of the country, while at the same time helping to stretch the defense budget and give troops the beneficial experience they needed. As well intended as the regulation was, it sometimes allowed troops to be used on small projects that were of questionable benefit when it came to enhancing the unit's real-life military capability.[418]

In 1952, the AEF drafted a new regulation, AFR 306-3, that tightened the criteria for training exercises, stating that, "The unit proficiency necessary to fulfill construction needs in areas of operation is best acquired and maintained through the employment of engineer aviation units in peacetime projects similar to those which they will be called upon to accomplish in time of war." Projects were supposed to lend themselves to accomplishment by a unit of company size or greater, and they were to clearly contribute to the training of the unit for its wartime mission. The ultimate aim was to acquire battalion-sized jobs where the command and staff could function in a realistic atmosphere. Better yet, a project that could employ a group headquarters and two or more battalions was ideal.[419]

It took some time before the battalion training concept could be realized. Personnel in the program were continuously siphoned off to fill overseas quotas and insufficient equipment was available for newly activated units. Despite the new regulation, the AEF continued to receive pressure from the major commands for SCARWAF units to perform a diversity of non-combat-related jobs. They also faced resistance from local communities in the vicinity of military bases, who preferred that any construction work be contracted to provide jobs for local companies. As a result, many large, battalion-size jobs were in remote areas, and AEF units were deployed to places in Alaska and the Caribbean to fulfill their training requirements. The 820th Engineer Aviation Battalion, for instance, received training at Beale AFB and gained some experience building roads to the rocket test facilities at Edwards AFB and laying a landing mat runway at Norton AFB, California, but then deployed to Elmendorf AFB, Alaska, to gain the bulk of its hands-on experience. They expanded runways and parking aprons at Cape Newenham and Northeast Cape Air Force Stations and constructed roads and a bridge at Galena Air Force Station.[420]

Large-scale deployments for training had the benefit of training engineers in all aspects of their mission. They learned the intricacies of packing up the unit, loading their equipment for sea or rail shipment, and then transporting, unloading, and unpacking their equipment, vehicles, and supplies on the other end. They employed flexibility and improvisation when their equipment did not arrive. Such training exercises brought into play the need for planning, engineering, and construction while using the entire command structure.[421]

In addition to training troops on construction equipment in the active inventory, the AEF felt it should play a role in determining the suitability of and acceptance testing of equipment destined for aviation engineer units to improve standardization and to ensure that units got the most effective equipment possible. In April 1954, the AEF finally received authority to get involved in the functional and operational suitability testing of three 50-ton crushing and screening plants. Requirements for the equipment were submitted in broad form to the Wright Air Development Center (WADC) at Wright-Patterson AFB, Ohio, where they were researched and developed in detail, with regard to engineering standards, materials, components, and parts. The detailed specifications that emanated from WADC were then handed to AMC for factory acceptance testing. After acceptance, equipment went to the Air Proving Ground Command at Eglin AFB for operational analysis and suitability testing, prior to returning to AMC for final acceptance and production procurement. The AEF argued that this arduous process was not always in the best interest of the Air Force and that standard commercial equipment would, in many cases, satisfy aviation engineer requirements. Aviation engineer units, for instance, did not need equipment with multi-purpose characteristics, such as a combat engineer unit might need. The aviation engineer workload was specialized to airfield construction - earth moving, compaction, and surfacing, structures, utilities, and services peculiar to air bases.[422]

One important by-product of the AEF's work was the standardization of an Operational Readiness Reporting System for Engineer Aviation Battalions. Detailed reporting on training-related construction activities — such as earth moving, paving, and heavy construction capability — gave the AEF a basis on which to develop and measure units. Three of the five categories for determining a unit's readiness were the result of arithmetic computations, allowing commanders to make fact-based decisions on their unit's capabilities. By 1955, the AEF was well on its way to refining a system that rated units objectively and on established criteria, a precursor of the Status of Resources and Training (SORTS) system later adopted by the Air Force.[423]

Another important contribution made by the AEF was toward the training and equipping of Air National Guard and Reserve engineer aviation battalions. Although the AEF had no direct responsibility for training Guard and Reserve units, it did try to monitor the readiness of units and maintain contact with them, mainly because the AEF would be the gaining command for such units if and when they were mobilized. In early 1955, the AEF visited units in 13 states to gather data on their overall operational status. They found that many units were less than five percent manned, without equipment, and had very limited training facilities. Other units were struggling to develop a nucleus around which an operating unit might be built. In general, all were poorly equipped and few had trained aviation engineer officers to serve as instructors.[424]

Following the visits, the AEF made a concerted effort to establish a relationship with units and provide them with technical assistance. It placed all aviation engineer units in the Guard and Reserve on the AEF mailing list for technical and standard publications. In summer 1955, the AEF sent liaison/observer teams to all five Air National Guard encampments. The goal was to establish a liaison with the various Guard state adjutants generals to develop encampment training programs geared to the aviation engineer mission. The AEF also encouraged reserve engineer units to take advantage of the training facilities at Wolters and Beale AFBs, which some did.[425]

In the two years after the end of the Korean Conflict, the AEF training program grew in strength and was just hitting its stride in 1955. The program, as it stood at the end of 1955, could provide battalion-size jobs for six of the 12 operational battalions assigned. During its five-year existence, the AEF conclusively proved the effectiveness of unit training on large-scale construction projects. The SCARWAF battalions of 1956 were much better prepared to construct air bases overseas than their earlier counterparts. The AEF also pointed proudly to the fact that it had provided approximately $190 million of in-place construction and disaster relief work for the Air Force.[426]

The End of SCARWAF

Following the end of the Korean Conflict, SCARWAF personnel included 1,750 officers and 30,000 enlisted personnel. Of these, 1,245 SCARWAF troops were assigned to NATO and working in Europe to construct housing, mess halls, offices, a service club, theatre and pre-fabricated structures.[427] In June 1953, the Secretary of the Air Force proposed again to the Secretary of the Army to transfer the SCARWAF units to the Air Force. Lt. Gen. George E. Stratemeyer, who served as Commander of the Far East Air Forces, argued that "the low combat effectiveness index of these units prior to the emergency has been confirmed under combat conditions. Had the Engineer Aviation units been operationally ready as were our fighter and light bomber units, the Engineer Battalions could have been utilized immediately in Korea as were our combat units. Had they been United States Air Force units, I feel certain they would have been operationally ready. I am left no alternative but to strongly urge the transfer of all responsibilities pertaining to Aviation Units to the Air Force."[428]

The Secretary of the Army agreed to the proposal in January 1954 and it was sent to the Secretary of Defense for signature in February 1954.[429] According to Maj. Gen. Guy H. Goddard, "we had hopes that eventually it would be an all blue-suit unit, but the crunch of spaces precluded that and it never came about."[430] The fate of SCARWAF lay in the Office of the Secretary of Defense. A three-person working group was established in the Office of the Secretary of Defense to study the problem. General Washbourne briefed the working group in March 1955 and both the Army and the Air Force answered extensive questions about the workings of the program. The Department of the Army withdrew its previous concurrence with the transfer and instead proposed that aviation engineer functions remain assigned to the Army.[431]

On December 2, 1955, the Deputy Secretary of the DoD Reuben B. Robertson, Jr., made the decision and issued a memorandum declaring that SCARWAF would be eliminated and that the Army would retain all aviation engineer personnel. Maj. (later Brig. Gen.) William T. Meredith described the meeting when General Washbourne learned of that decision,

> In the 1955 or 1956 timeframe, when it was time to transfer those troops over, I was with General Washbourne the day he went to see the new Secretary of the Air Force, Dr. [Donald A.] Quarles. He had the order all typed. He briefed the secretary and laid the order in front of him on the desk. The secretary looked at him and said, "I don't believe in this. It's a function that belongs to the Army." Washbourne dropped his charts in the middle of the floor, turned around and walked out. I was the chart carrier, so I picked up the charts and got out of there.[432]

The December 2, 1955 memorandum signed by Deputy Secretary Robertson abruptly stated: "I have been advised that the SCARWAF arrangement is unsatisfactory because it is administratively cumbersome, is not sufficiently responsive to the needs of either the Air Force or the Army, and its costs are excessive and not commensurate with values received." The specifics of the elimination of SCARWAF were stated in the memorandum: "(1) the SCARWAF category is abolished and all SCARWAF units and Army personnel will be returned by the Department of the Air Force to the operational direction and control of the Department of the Army, (2) the Department of the Army will be responsible for providing overseas military construction support to the Air Force." The letter further specified that these two requirements be completed by March 1, 1956.[433] Four SCARWAF units remaining in Europe were inactivated in February 1956; the remaining 10 were reassigned to the Army in March 1956.[434] Twenty-four thousand engineers detailed to the Air Force returned to the Army.[435]

During the dissolution of SCARWAF, the Air Force and the Army discussed their respective roles in troop construction in overseas contingency situations and the numbers of troop requirements forecast by the Air Force. For FY58, the Air Force requested the support of six Army engineer battalions during peacetime. The Army questioned this requirement as too large. Yet, even while the Army argued vigorously to retain the role of providing troop construction to the Air Force, it was reducing manpower and the overall number of its engineer battalions due to budget cuts and the implementation of a new plan.[436] The new plan authorized 7,500 Army engineers to support both Air Force and Army needs during contingency situations. Air Force requirements needed to be met in the earliest stages of a typical contingency situation, while Army needs occurred later in time. Therefore, the 7,500 Army engineers were calculated to be enough personnel to meet the maximum requirements of both the Air Force and Army at any one time after mobilization began.[437] The remaining troop spaces previously used by the Air Force were placed in the Army Reserves.[438]

In a memo dated September 29, 1955, the Secretary of the Air Force informed the Secretary of Defense that it was incumbent on the Air Force to incorporate within its structure the capability to restore combat operations on a limited emergency basis following enemy attack. A new organizational concept was outlined in the memo that allocated 7,000 additional spaces to the Air Force to implement a bomb damage recovery plan. In a January 3, 1956 meeting with the Director of Operations and the Director of Logistics Plans, the chief of the Installations Engineer Division agreed to provide a detailed plan to develop Air Force bomb damage repair capabilities. The plan submitted for staffing on January 5, 1956 proposed augmenting installations squadrons at a number of war mission bases and placing additional cadres of supervisors and technicians at several non-primary target bases. These personnel would be equipped with equipment from the SCARWAF program and reserved for Air Force use in case of enemy attack, emergency, or natural disaster.[439]

The proposed plan submitted to the Secretary of the Air Force to gain additional personnel authorizations to develop an internal capability for bomb damage repair was unsuccessful because of higher priority requirements. The Assistant Chief of Staff, Installations then turned to the major commands to establish the new mission within current personnel allocations. An installations engineer conference was held in October 1956 in Washington, D.C., where various aspects of the new mission assignment were discussed and ideas exchanged. An outline of a base recovery plan was developed and presented at the conference. A letter dated October 31, 1956 was distributed to major commands that provided initial data to assist in developing requirements for feasible recovery operations. The Table of Allowances for Installations Engineer equipment was amended to include 22 items for the effort by November 1956. Although it was recognized that other Air Force elements were involved in implementing a full scale disaster recovery plan, the Assistant Chief of Staff, Installations pressed forward to establish Installation Reserve units, emergency survival component items, new disaster-survival standard airfield criteria, and training for installations personnel in post-attack decontamination and repair procedures.[440]

In February 1957, DoD Directive 1315.6 entitled *Responsibilities for Military Troop Construction Support of the Department of the Air Force* was issued to clarify the responsibilities for airfield construction and maintenance in overseas contingency situations. This directive stated:

> A. The Department of the Army is responsible for providing military troop construction support to the Air Force overseas, including:
>
> 1. Organizing, manning, training, equipping, maintaining, directing, and controlling all units and personnel, including those of the reserve components, required to provide this support.
> 2. Budgeting and funding for the required units.
>
> B. The Department of the Air Force is responsible for developing and maintaining a capability for the emergency repair of bomb damaged air bases within the organic capability of air installations resources. A limited number of specialists may be provided and additionally to supervise development of this capability.[441]

Once again, the Air Force was without dedicated construction units and was forced to rely upon the Army during times of war. But the window of opportunity was given to the Air Force engineers to develop an organic capability for emergency repair to Air Force installations apart from Army assistance.

Lebanon Crisis

Although an official directive was in place that directed the U.S. Army Corps of Engineers to provide military troops construction support to overseas Air Force bases in contingency situations, how that directive worked in reality was still to be field tested. In 1958, the Air Force experienced the limits of that directive.

In July 1958, the Air Force encountered a contingency in Lebanon. Amid tensions between Egypt and Lebanon's political factions, the Lebanese government was threatened with a coup. Answering Lebanese President Camille Chamoun's call for help, President Dwight D. Eisenhower deployed 5,000 Marines on July 15. Incirlik AB, Turkey, was designated as the staging base for all operations during the conflict. Problems quickly arose at the air base. The base installations squadron was small

Air Force Douglas C-124 Globemaster airlifting personnel and cargo during the 1958 Lebanon Crisis.

in size and base maintenance was performed by civilian contractor personnel who had been at the base for only 15 days. Base facilities were constructed to support a minimal operating force and the rapid buildup of troops stretched available utilities and POL facilities beyond their capacity. Electric generators and potable water supply were particularly in short supply.[442]

The situation at Incirlik AB quickly deteriorated. Runway repairs were needed due to constant aircraft use; water systems were greatly overburdened; and some Airmen had to sleep on the ground until tents or other housing was made available. After the contract was modified, the civilian contractor pulled workers from other construction sites to supervise temporary teams of local labor to support 24-hour contingency operations. Supplemental tents and electric generators were airlifted in from other USAFE bases. The U.S. Army Corps of Engineers was requested to provide construction support to install a four-inch water pipe to alleviate the water supply problems. One engineering unit was diverted to the base to complete the construction project.[443] Despite all of the shortages, Incirlik AB was able to provide continual support to the Marines during the Lebanon Crisis.

A history done by the Air Force Historical Division in 1962 described the difficulties, "Most of the problems encountered by the Air Force resulted from the lack of adequate facilities and procedures to meet either scheduled or unscheduled requirements….The fundamental problem underlying the operational and logistical difficulties was the lack of bases in the operational area."[444] In the aftermath of the Lebanon Crisis, USAFE officials recognized the urgency to develop and maintain a capability to manage further contingencies to augment support from the U.S. Army Corps of Engineers and without relying solely on contractor support. USAFE's Directorate of Civil Engineering surveyed all USAFE air bases to study all operations and maintenance capabilities. Two proposals were made. The first proposal was to contract maintenance and construction support with NATO host nations. The second proposal was to establish a USAFE Civil Engineer Mobile Team. The Civil Engineer Mobile Team Concept was based on the following principles:

1. Team composition was limited in size. (Airmen comprising the team had to come from available USAFE personnel resources).
2. The team comprised detachable cells capable of providing limited emergency operation and maintenance services at forward operating bases.

3. The entire team supported only essential operation and maintenance functions.
4. The team had no construction capability. (The U.S. Army Corps of Engineers would provide needed construction services).
5. The team had to be highly mobile and fast reacting.
6. Finally, the team's role was to augment an existing civil engineer force. In the event of withdrawal of a civilian work force, the team required a capability to provide the most essential utilities and facilities operation until augmented by a military personnel build-up.[445]

USAFE adopted the Civil Engineer Mobile Team Concept and teams were formed for prompt deployment when required. These teams were the forerunner of the Prime Base Emergency Engineering Force (Prime BEEF) program that was established during the 1960s.

THE END OF THE 1950S

By the late 1950s, Air Force civil engineers found themselves facing new challenges and levels of responsibility that required a commensurate increase in professional development. As Maj. Gen. Lee B. Washbourne stated the challenge:

> The bases and facilities supporting our air power reflect the technical and professional ability of the engineer to match the ever-increasing performance of weapon systems. The installations engineer can never rest on his laurels; he must plan our Air Force support operations with vision, ingenuity, and skill, if our air power is to maintain a dominant position in the world. The military engineer will maintain his place in the art of war by keeping his techniques sharp, his imagination vivid, and his understanding adequate.[446]

About a year and a half after becoming Director of Installations in July 1957, Maj. Gen. Augustus M. "Gus" Minton presided over a session at the Worldwide Installations Engineer Conference at Ramey AFB, Puerto Rico. General Minton made a presentation on the evolution of the role of engineering in the Air Force. He pointed out that technological developments in aircraft and their servicing and support facilities required that aviation engineers be familiar with many branches of the engineering profession. One important aspect of engineering in the Air Force, General Minton recalled, was:

> building confidence on the part of our people and pride in the job they were doing. I had always had the feeling that the base engineering people were considered kind of the base handyman. He was the guy you called when the toilet wouldn't flush. Too often they thought he would show up with a bulldozer in the front lawn, digging up the lawn. That was the feeling that I think most people had about the installation officer on the field at that time.[447]

At the end of the presentation, General Minton proposed that the organization be renamed civil engineering. He proposed that the name "civil engineering" to connote "professionalism and a background of educational experience that makes it a profession."[448]

On March 7, 1959, the Directorate of Installations was redesignated the Directorate of Civil Engineering. As part of this change, the title of the Director of Installations was changed to Director of Civil Engineering. Two other job titles also were redesignated. The Installations Engineer Staff Officer became the Civil Engineering Staff Officer, and the base Installations Officer became the Base Civil Engineer.[449]

The span of time between 1947 and 1959 was pivotal for the Air Force and Air Force Civil Engineering. The Air Force was created as a separate branch of the U.S. military and proceeded to define its role in air defense. Air Force civil engineers established policies and procedures to accomplish Air Force construction programs and maintain and operate a growing number of permanent air bases both in the United States and overseas. In particular, through their involvement in the Berlin Airlift, the Korean Conflict, and the Lebanon Crisis, Air Force civil engineers demonstrated their abilities and established themselves as a valued branch of the Air Force in support of contingency situations. The performance of SCARWAF during the Korean Conflict reinforced the theory that the Air Force needed a dedicated contingency capability. In addition, missile development, the creation of early radar systems, and the construction of the USAFA were giant leaps for the Air Force civil engineers and further illustrated their capabilities. By the close of the 1950s, the Air Force was a seasoned member of national military establishment. Although they still faced challenges ahead, Air Force civil engineers had progressed from handymen to professionals.

CHAPTER 3

RISING TO THE CHALLENGE 1960-1974

INTRODUCTION

Contingency deployments to Vietnam and Southeast Asia dominated Air Force civil engineering activities from 1960-1974. Throughout the period, Cold War tensions remained high between the United States and Communist nations, most notably the U.S.S.R. and China. Several incidents led to military alerts that strained international relations. These events included the construction of the Berlin Wall in 1961, the Cuban missile crisis in 1962, the U.S. involvement in the Republic of Vietnam between 1961 and 1973, and heightened tensions on the Korean peninsula in 1968.

While Air Force civil engineers supported the U.S. military response to all of these events, the Vietnam conflict necessitated a particularly long-term and high profile commitment on the part of Air Force civil engineers. The involvement of Air Force civil engineers in Southeast Asia greatly influenced the organization, impacted individual personnel, and shaped civil engineering activities. Many career Air Force civil engineering personnel, who had joined the Service during World War II, served in leadership roles during the Vietnam Conflict. For the younger generation of Air Force personnel, the Vietnam conflict became their war. Air Force leaders of the 1980s and early 1990s forged their careers supporting the Air Force mission in Southeast Asia. The Air Force Civil Engineering motto "Can Do—Will Do" clearly was internalized during the Vietnam conflict.

Ongoing deployments to the Republic of Vietnam and other areas in Southeast Asia spurred innovation at all levels of the Air Force civil engineering organization. Throughout the period, Air Force civil engineers functioned in dual roles. Engineers served as engineer-managers for a variety of diverse projects and maintained the hands-on capabilities necessary to support the Air Force mission at bases in the United States and overseas. Innovations were introduced during the period in the operation of the permanent Air Force bases, in personnel management, in design and construction, and in contingency preparedness and planning. New challenges for the Air Force and civil engineers required flexible and dynamic responses. The engineering lexicon expanded to include such terms as "missiles," "space program," "bare base," "relocatable housing and structures," and "turnkey construction projects."

Among the most important developments of the period was the expanded role of Air Force civil engineers in expeditionary construction during contingency situations. Nearly simultaneously, the Directorate of Civil Engineering implemented the Base Engineer Emergency Force, known as Prime BEEF, and troop construction capability, known as Rapid Engineer Deployable Heavy Operational Repair Squadron, Engineer or RED HORSE. The implementation of Prime BEEF aligned Air Force civil engineers to support Air Force contingencies and base emergencies. RED HORSE squadrons undertook troop construction in contingency situations, thus reducing reliance on Army support that historically proved problematic. Prime BEEF teams and RED HORSE squadrons were deployed immediately to Southeast Asia and South Vietnam where they successfully completed a wide range of projects critical to the support the Air Force mission.

Air Force budget levels during the period varied greatly and were dependent upon national policy and Congressional approval. In 1964, the Department of Defense ordered base closures and the realignment of military units, both in the United States and overseas. As U.S. involvement in Vietnam escalated, construction budgets in the continental United States (CONUS) were frozen in October 1967; funds were directed towards construction projects in Southeast Asia and the development of new weapons systems. By 1968, the Air Force had relinquished 110 obsolete missiles sites, obsolete radar stations, and six air bases in CONUS. Overseas, 64 installations in France were closed following that country's withdrawal from the North Atlantic Treaty Organization (NATO) in 1966. In September 1969, President Richard M. Nixon imposed a 75 percent reduction in Federal construction, eliminating $146 million earmarked for the Air Force. During the early 1970s, President Nixon continued dramatic reductions to defense expenditures and ended U.S. involvement in South Vietnam. Nixon adopted the policy that the United States would not commit ground forces to address conventional threats to the security of allied countries, aside from South Korea and NATO allies of Western Europe.

CIVIL ENGINEERING AIR STAFF PROGRAMS AND POLICIES

Directors of Civil Engineering

Five Directors of Civil Engineering led the organization during this period: Maj. Gen. Augustus M. Minton (1957-1963), Maj. Gen. Robert H. Curtin (1963-1968), Maj. Gen. Guy H. Goddard (1968-1971), Maj. Gen. Maurice R. Reilly (1972-1974), and Maj. Gen. Billie J. McGarvey (1974-1975). Each director shaped the organization through procedures and policies rooted in his professional experiences. General Minton was the longest serving director, followed by General Curtin. After General Minton, subsequent directors typically were chosen from among the deputy directors within the directorate. The succession of deputy director to director was pragmatic and assured continuity in implementing programs and initiatives within the Directorate of Civil Engineering as well as maintained corporate knowledge of current processes, procedures, and working relationships within the Pentagon and the U.S. Congress. Some directors retired from the office, while others assumed command or higher headquarters positions.

Maj. Gen. Augustus M. "Gus" Minton served as Director of Civil Engineering until July 1963 and held the distinction of the longest serving director. His longevity contributed to his pivotal leadership in establishing the structure and mission of the Air Force civil engineering organization. General Minton recognized the changing role of the Air Force civil engineer from "handyman" charged with

Maj. Gen. Robert H. Curtin

maintaining Air Force bases, to professional, meeting the technological challenges of basing an aerospace force.[1]

General Minton was a strong proponent of continuing education and professional registration as a means to support the responsiveness of Air Force civil engineers to the evolving challenges faced in accomplishing the U.S. Air Force mission. As part of this drive for professionalism, General Minton continued the annual world-wide civil engineering conferences, founded the *Air Force Civil Engineer*, and established in 1960 an annual award for the best article appearing in the magazine. The award became known as the Maj. Gen. Augustus M. Minton award.[2] General Minton also supported Air Force education programs and sponsored Operation Cool School, an annual inspection of Arctic sites by educators in the United States.[3]

As director, General Minton oversaw the construction of a variety of technologically complex facilities associated with the early warning system and intercontinental ballistic missiles, and family housing units under the Capehart program. He also supported the adoption of advanced base-level management strategies for operations and maintenance, such as the establishment of the work control center and new cost accounting controls. General Minton was noted for his thorough and persuasive presentations in defense of Air Force construction programs before Congress and "earned the admiration and respect of all who worked for and with him."[4]

In July 1963, Maj. Gen. Robert H. Curtin, a graduate of the U.S. Military Academy at West Point, became Director of Civil Engineering. General Curtin's previous positions included Deputy Director for Real Property, Deputy Director for Civil Engineering Operations, and Deputy Director for Construction under General Minton. General Curtin served as Director of Civil Engineering until May 1968. The major buildup of U.S. forces in the Republic of Vietnam occurred during his tenure as director. Air Force civil engineers were assigned as part of regular tours of duty to operate and to maintain the bases that supported the Air Force mission. Under General Curtin's direction, civil engineering embarked on a major restructuring and reorganization effort known as Project Prime BEEF for Base Engineer Emergency Force. In 1965, the first two Rapid Engineer Deployable Heavy Operational Repair Squadron, Engineer (RED HORSE) squadrons were formed to undertake heavy repair and maintenance work. Both Prime BEEF teams and RED HORSE squadrons were vital to support Air Force contingency operations in South Vietnam and Thailand. Their projects included revetments, hardened aircraft shelters, roads, runways and aprons, troop housing, and other facilities. Under General Curtin, the Air Force was appointed the construction agent for all phases of Tuy Hoa Air Base (AB), Republic of Vietnam, which was completed on time and within budget during 1966 and 1967. Prime BEEF teams also were deployed to assist bases during natural disasters, thereby establishing a stateside role for Prime BEEF teams in base recovery. In 1966, General Curtin established the Civil Engineer Construction Operations Group (CECOG) at Wright-Patterson AFB to oversee Prime BEEF and RED HORSE operations.[5]

As director, General Curtin continued support for the base level civil engineer. He advocated for professional development among the civil engineers and supported the "Can Do-Will Do" spirit with enthusiasm. General Curtin worked to improve civil engineering participation in the budget processes for the military construction program (MCP) and the operations and maintenance (O&M) account. While financial resources were directed to support contingency operations, budgets for stateside base operations were reduced. General Curtin initiated procedures to improve budget justifications through "Total Programming" and successfully defended budgets before the U.S. Congress. He supported the initial development of automated data processing systems to improve management techniques that subsequently led to the creation of the Base Engineer Automated Management System (BEAMS).[6] He also oversaw the beginning of the Air Force response to the remediation of environmental pollution after Executive Orders were signed supporting the cleanup of water and air pollution.[7]

The annual Curtin Award was established to recognize the contributions of base level civil engineering organizations. As General Curtin recalled,

> It got established…because I was concerned about several things, one of them being that we weren't paying enough attention to the base engineers. We were more worried about construction and those kinds of things, rather than the day-to-day activities that base engineers performed. I started it because I wanted to give more recognition to the base engineers.[8]

The Curtin Award remains the Air Force Civil Engineering's most prestigious award. It is presented annually by the Society of American Military Engineers (SAME) to the most oustanding large, small, and Air Reserve Component civil engineer units.[9] [See Appendix B]

Maj. Gen. Guy H. Goddard served as Director of Civil Engineering from May 1968 through December 1971 after serving as Deputy Director for Construction from 1965 to 1968. General Goddard was a 1941 graduate of the U.S. Military Academy at West Point. General Goddard oversaw the Air Force Capehart family housing construction program from 1957 to1962, and the construction of air bases in Southeast Asia between 1965 and 1968. He also served as the Air Staff monitor for the construction of Tuy Hoa AB in the Republic of Vietnam while deputy director.[10]

During his time as director, the directorate underwent a significant reorganization as the civil engineering workforce was reduced from 100,000 to approximately 80,000 at the end of the Vietnam conflict. Budget requests received intense scrutiny and appropriations were impacted by rising economic inflation. "Doing more with less" became a continuous refrain.

General Goddard implemented more effective management strategies throughout the Air Force civil engineering organization, including at the base level. He supported improved cost control procedures and the adoption of new construction techniques to maximize military construction dollars. A proponent of "management by objectives," he published annual objectives in the *Air Force Civil Engineer*. He implemented a top-to-bottom management review of policy objectives and instituted

Maj. Gen. Guy H. Goddard

performance goals and standard management tools through such programs as BALANCE and total programming. General Goddard also oversaw the implementation of BEAMS on the base level to strengthen the reporting tools to improve base management.[11]

General Goddard counted the establishment of the Civil Engineering Center at Wright-Patterson AFB, Ohio, among his greatest accomplishments as director. Another of General Goddard's accomplishments was revitalization of the military family housing construction program. As Director of Civil Engineering, General Goddard designed and implemented the Turnkey housing program. In addition, he supported two-step procurement and the adoption of industrialized construction techniques to streamline new construction. Another of his priorities as director was to strengthen the role of the Air Reserve forces in support of Air Force missions.[12]

General Goddard was also a proponent of Air Force civil engineer participation in national societies. While director, he also served a term as president of SAME. During his time as president, Air Force participation in SAME greatly increased. The Goddard Medal was established in his honor to acknowledge the accomplishments of Air Force civil engineers. Three medals are presented annually to one active duty, one Reserve, and one Air National Guard individual for outstanding contributions to military engineering, including military troop construction, base maintenance, and contingency engineering.[13]

Maj. Gen. Maurice R."Tex" Reilly served as the Director of Civil Engineering from January 1972 to March 1974. General Reilly previously served as deputy director from 1968 through 1971 and Director of Civil Engineering at the Air Force Systems Command from 1965 to 1968. Among the challenges met under General Reilly's tenure were compliance with new environmental regulations, particularly those designed to limit and control air, water, and noise pollution. General Reilly also provided leadership during the energy crisis of the early 1970s. Energy reduction and conservation programs, including the modernization of the Air Force infrastructure to increase energy efficiency, were advanced to counter anticipated fuel shortages. Concern increased over the encroachment of

Maj. Gen. Maurice R. "Tex" Reilly

civilian construction on previously undeveloped land immediately surrounding major air bases during General Reilly's tenure. Concerns were raised by neighboring residential and commercial development about potential noise pollution and accident hazards associated with normal Air Force flying operations. The Directorate of Civil Engineering responded to these concerns through the Air Installation Compatible Use Zone (AICUZ). This program established a regional community planning process for areas surrounding air bases and fostered a new era of cooperation between Air Force bases and civilian communities. General Reilly also presided over a shift in construction priorities and associated budgets. New construction fell in importance as fewer new facilities were needed to bed down new weapons systems, while improvement and modernization of existing Air Force facilities rose in importance. Budgets were adjusted accordingly. In FY74, nearly 65 percent of construction funds were spent on modernization, repair, and upgrades to facilities as compared to 20 percent in FY70.[14]

During the downsizing that followed the Vietnam conflict, General Reilly sought to strengthen contingency planning and to retain the engineering capability embodied in Prime BEEF and RED HORSE. "We must sustain what the war in Southeast Asia set in motion. We cannot afford to have another lull in progress such as that which occurred between the end of World War II and the mid 1960s," he forcefully reasoned. General Reilly foresaw that projected budget cuts in the coming years would result in pressure to diminish or disband the Prime BEEF and RED HORSE programs. The transition to an all-volunteer military also represented a major military-wide change with future ramifications for Air Force civil engineering. General Reilly acknowledged the new reality when he reiterated the mission of Air Force civil engineering,

> Without ground facilities, aircraft and missiles don't fly. On the personnel side we should consider the intimate daily association one has at an air base with facilities and the related activities of civil engineers. The morale, well being and job effectiveness of Air Force people are closely tied to their facilities environment.[15]

Maj. Gen. Billie J. McGarvey

Maj. Gen. Billie J. McGarvey assumed the office of Director of Civil Engineering on March 1, 1974 and served until April 1975. General McGarvey had served as deputy director since 1972. Previous assignments included tours of duty as the Deputy Chief of Staff for Civil Engineering at Headquarters Pacific Air Forces and Deputy Chief of Staff at Air Force Logistics Command. Prior to major command assignments, General McGarvey served as Chief, Construction Division, Air Staff. In 1966, he worked as the special assistant to the Director of Construction for the Tuy Hoa Turnkey project.

At the beginning of his tour as Director of Civil Engineering, General McGarvey identified the challenges before him as managing a "declining manpower structure sandwiched between the constraints of reduced operating budgets, aging facilities and unyielding mission responsibilities." In addition, the challenges associated with the energy crisis, environmental regulations, and air base encroachment continued. At the end of his service, General McGarvey reported, "we are making significant inroads on many of these issues—our AICUZ program is well underway to preclude further encroachment on our air bases; our engineering designs for construction strive to minimize energy consumption, while providing optimum functional facilities; and we have become the front runner in the use of environmental impact assessments for decision making." Work also progressed on streamlining procedures and introducing workable management innovations and improvements. On April 1, 1975, General McGarvey was reassigned as Assistant Deputy Chief of Staff, Programs and Resources.[16]

Organizational Changes, 1960-1974

Air Staff

Between 1960 and 1974, the Directorate of Civil Engineering at the Pentagon underwent several organizational changes. Flexibility, initiative, and overall professionalism were tested as the organizational structure and personnel assumed added responsibilities in CONUS and overseas. The organization strove to fulfill its mission to provide, operate, and maintain the facilities required to support U.S. air power at home and world-wide.[17]

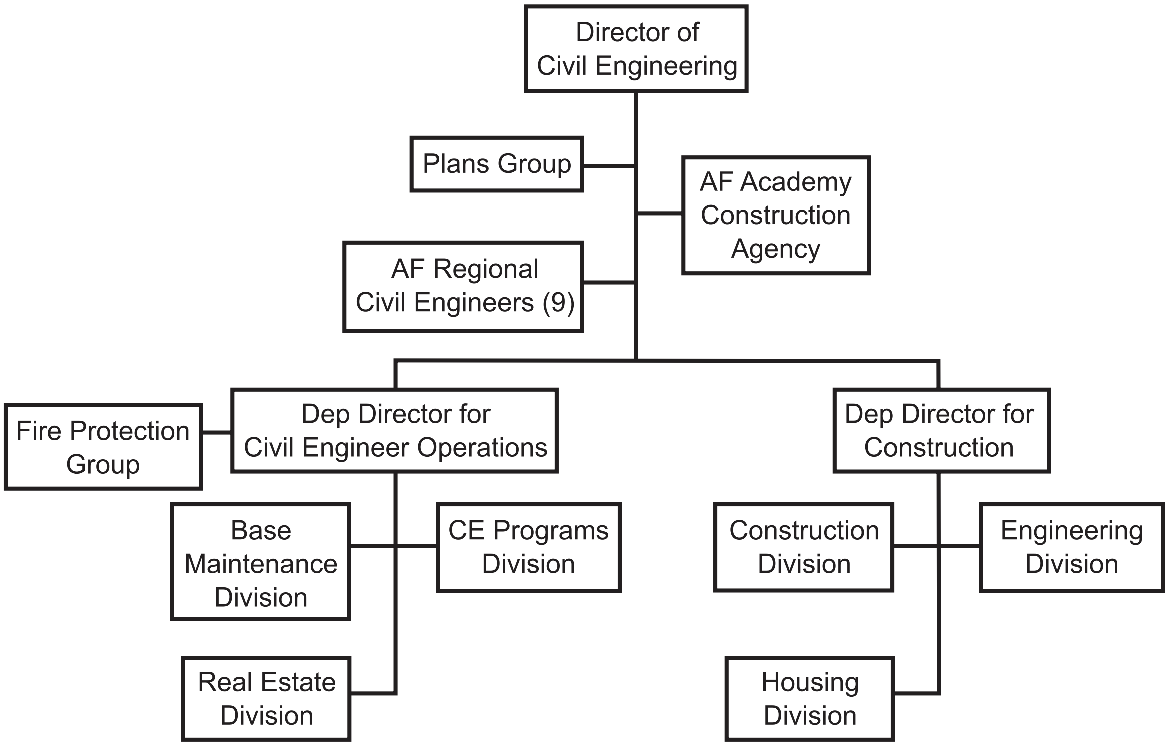
The Directorate of Civil Engineering was responsible for the establishment of policies and procedures, real property maintenance and management, fire protection and aircraft-missile rescue services, formulation of the military construction program and its presentation to the U.S. Congress, engineering, design, and construction of Air Force real property facilities, and, administration of the Air Force housing construction program. In 1960, the military construction budget included $750 million for new construction and $750 million for maintenance and operations.[18] Staffing strength for the Directorate in 1961 was 411.[19]

In 1960, Air Force civil engineering personnel serving at the Pentagon, major commands, and at the bases world-wide included 2,000 officers, 38,000 Airmen, and nearly 60,000 civilians. These personnel operated and maintained Air Force facilities at 250 major bases and at over 3,200 other installations. The total value of Air Force facilities maintained by Air Force civil engineers was over $11 billion.[20] By 1963, that value had increased to $15 billion.[21]

In 1974, Air Force civil engineering personnel, including military and civilian, numbered 76,000. These personnel managed a physical plant with a replacement value of over $55 billion. Air Force civil engineering personnel managed annual budgets during the early 1970s ranging between $1.5 and $2 billion for the acquisition of new facilities and the maintenance of existing facilities.[22]

In February 1960, the Directorate of Civil Engineering, Headquarters, U.S. Air Force, was reorganized under the Director of Civil Engineering, Maj. Gen. Augustus M. Minton. General Minton was assisted by an Assistant Director of Civil Engineering and an executive staff. The number of deputy directors was reduced from three to two; the position of Deputy Directorate for Facilities Support was abolished. The two remaining deputy directors oversaw six divisions.[23] The Deputy Director of Civil Engineering Operations headed by Brig. Gen. Robert H. Curtin oversaw the Programs, Real Estate,

Figure 3.1 Directorate of Civil Engineering, 1960



Source: Directorate of Civil Engineering Organizational Chart, Files of AFCEC History Office.

and Base Maintenance Divisions. The Fire Protection Group also reported to General Curtin. The Deputy Director of Construction headed by Brig. Gen. Harold K. Kelley oversaw the Construction, Engineering, and Housing Divisions. The nine Air Force Regional Civil Engineer offices reported directly to the Director of Civil Engineering (Figure 3.1).[24]

By July 1961, the divisions under the two deputy directors were realigned. The Deputy Director for Operations, Col. Winston Fowler, assumed responsibility for the Fire Protection Group and the Housing, Base Maintenance, and Real Estate Divisions. The Deputy Director for Construction, Brig. Gen. Robert H. Curtin, oversaw the Civil Engineering Control Group, and the Construction, Engineering, and Programs Divisions.[25] In 1962, the Directorate of Civil Engineering was moved from Deputy Chief of Staff/Operations to Deputy Chief of Staff/Programs and Resources (DCS/PR) in the Air Force organizational chart.[26]

Effective January 1, 1963, the Real Estate Division was renamed the Air Force Real Estate Agency and became a field extension office of the Directorate of Civil Engineering. The agency was located with the 1132d Air Force Special Activities Squadron at Bolling AFB, Washington, D.C. The new agency assumed the functions and authorized personnel strength of the former division.[27]

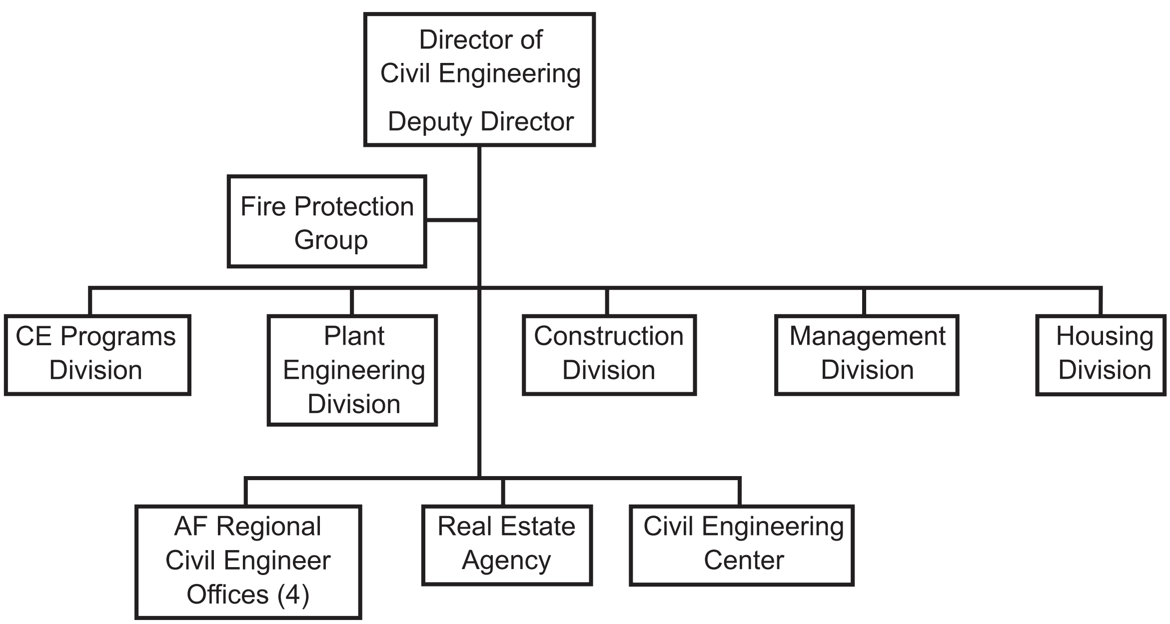
In 1964, the Engineering Systems Branch was established. This branch was responsible for research, development, and control of civil engineering management systems.[28] The establishment of the Engineering Systems Branch was prompted by the introduction of automated systems for budgeting and engineering applications. One of the first objectives of the Engineering Systems Branch was conducting a comprehensive study to compile data to support the development of a standard civil engineering management system for use by all Air Force civil engineers world-wide. Such a system was proposed to improve the decision-making process.[29]

In 1968 under General Goddard, the organizational structure of the Directorate of Civil Engineering again was reviewed extensively. As a result, the directorate was reorganized effective June 17, 1968.[30] Major organizational changes included realigning upper management, changing the number and functions of the directorate's divisions, reducing the number of the Air Force Regional Civil

Engineer offices, and forming the Civil Engineering Center (CEC).[31] The reorganization centralized management, streamlined communications among divisions and base personnel, provided single point programming for policy management, and empowered division chiefs with greater authority and responsibility in their respective areas. The Director of Civil Engineering, Maj. Gen. Guy H. Goddard, was assisted by Mr. John R. "Jack" Gibbens as associate director. The deputy directors of Construction and Civil Engineering Operations were eliminated and a single deputy director was established, so that the divisions, groups, and agencies interacted directly with the director's office and more closely with each other. Brig. Gen. Maurice R. "Tex" Reilly became the deputy director. Mr. Rufus "Davey" Crockett and Mr. Louis A. Nees served as the two associate deputy directors. The role of the associate director and the associate deputy directors was to assist in formulating policy and to coordinate special projects and committees.[32] In 1970, Mr. Crockett became the associate director and Mr. Harry P. Rietman and Mr. Nees served as associate deputy directors.[33] In 1973, Mr. Rietman was appointed the third civilian associate director of civil engineering. The Air Force civil engineer annual award for outstanding senior civilian civil engineers was named in his honor following his retirement in 1985. [34]

The directorate was divided into five divisions under the 1968 reorganization: Housing, Maintenance (renamed Management by 1970), Programs, Plant Engineering, and Construction. The Housing Division was responsible for all aspects of family housing, including planning, funding procurement, construction, operations and maintenance, and disposal. Family housing was funded through a single Congressional appropriation and tracked separately by the Office of the Secretary of Defense. The Programs Division was responsible for all other programming. These responsibilities included approving and distributing funding allocated to civil engineering through MCP and minor construction, non-appropriated, and operations and maintenance funds. This division also was a member of the Air Staff's Program Review Committee, which allocated the overall Air Force budget. The division was represented on the Budget Review Committee and served as the chair of the Facilities Review Committee that advised the Director of Civil Engineering on allocations for the MCP. The Plant Engineering Division oversaw the management processes and controls required to maintain, operate, and update the growing and diversified inventory of Air Force facilities. This division also oversaw engineering criteria and standards for air conditioning, pavements, and structures. The Construction Division

Figure 3.2 Directorate of Civil Engineering, 1970



Source: Maj. Gen. Guy H. Goddard, "Concepts of Operations: New AFOCE Organization," Air Force Civil Engineer, Vol 11, No 2, May 1970, 10.

monitored all construction management from final design through construction. Previously, the division had focused exclusively on the MCP; these duties now were expanded to include non-appropriated funds, major and minor repairs, and major and minor maintenance. The Management Division was responsible for automation, cost accounting, quality control, and force levels (Figure 3.2).[35]

The Real Estate Agency, the Fire Prevention Group, the Air Force Regional Civil Engineer offices, and the Civil Engineer Center reported to the Director of Civil Engineering. The Real Estate Agency managed real estate acquisitions, current inventory, and disposal. The Fire Prevention Group developed policies, programs, standards, and technical procedures for fire prevention, protection, and air crash rescue. The number of Air Force Regional Civil Engineer offices was consolidated from eight to four, and selected functions were reassigned to major commands. The four consolidated offices were the Western Region in San Francisco, California; the Central Region in Dallas, Texas; the Eastern Region in Atlanta, Georgia; and the Canadian Region in Ottawa, Canada. The three U.S. offices were staffed by 25 to 30 persons who worked with the U.S. Army Corps of Engineers and the Navy to define design parameters to meet Air Force construction requirements within reasonable costs.[36] The Canadian Regional Office was subsequently closed June 30, 1971.[37]

The Civil Engineering Center at Wright-Patterson AFB, Ohio, was the largest entity reporting to the Director of Civil Engineering. The center was created to support field activities and to perform contingency planning. It was responsible for ensuring civil engineering mobility to respond to air base emergencies and contingencies world-wide. Duties of the center included the assessment of personnel, training, and equipment needs, with special emphasis on Prime BEEF and RED HORSE programs. The center also responded to base requests for specialized technical support in the areas of pavements evaluation, corrosion control, forestry management, snow and ice removal, fire protection, and procurement of specialized services.[38]

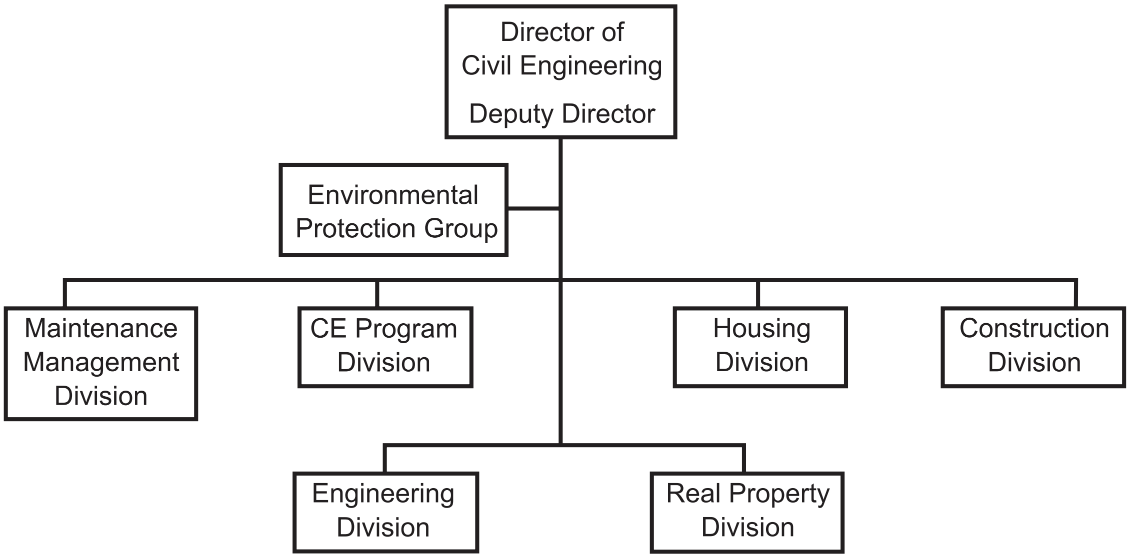
The Environmental Protection Group was established in the Directorate of Civil Engineering on July 24, 1970, following the designation of the Directorate of Civil Engineering as the lead for environmental protection matters on the Air Staff. The new group comprised three officers and eight civilians.[39] The Environmental Protection Group developed policies, programs, and procedures for the protection of environmental quality and management of natural resources conservation programs.[40]

In 1971, the number of divisions in the Directorate of Civil Engineering was reduced from five to four: Housing, Civil Engineering Programs, Plant Engineering, and Management. The former Construction Division was merged into the Plant Engineering Division to improve the management of Air Force design, construction, and maintenance. The Plant Engineering Division's expanded mission encompassed criteria and policy development, design, construction, maintenance, and utilities systems operations. The division was organized into three branches: Engineering Operations, Structures, and Utilities.[41]

This reorganization also resulted in a physical relocation of some divisions. Previously, sections of Air Force civil engineering were dispersed among several locations in Washington, D.C., and its suburbs. The Housing Division and the Fire Protection Group moved from Temporary Bldg T-8 to the Pentagon and acquired space previously occupied by the Construction Division. The Plant Engineering Division was moved to Building 626 at Bolling AFB, already occupied by the Real Estate Agency.[42]

In 1972, U.S. Air Force Headquarters required that the Air Staff shed all field extensions and the Directorate of Civil Engineering (AF/PRE) again underwent reorganization. The former Real Estate Agency became the Real Property Division (AF/PRER), one of six new divisions. The other five divisions were Engineering (AF/PREE), Maintenance/Management (AF/PREM), Civil Engineering Programs (AF/PREP), Housing (AF/PREN), and Construction (AF/PREC) (Figure 3.3). The Real Property, Engineering, and Construction divisions all resided at Bolling AFB at this time. The three Air Force Regional Civil Engineer offices became detachments of the 1137th Special Activities Squadron of Headquarters Command. The Civil Engineering Center was transferred to the Air Force Systems Command in June 1972. Nineteen policy functions formerly executed by the center reverted to Air

Figure 3.3 Directorate of Civil Engineering, 1972



Source: "The 'New Look' at AF/PRE," Air Force Civil Engineer, Vol 14, No 1, Feb 1973, 3.

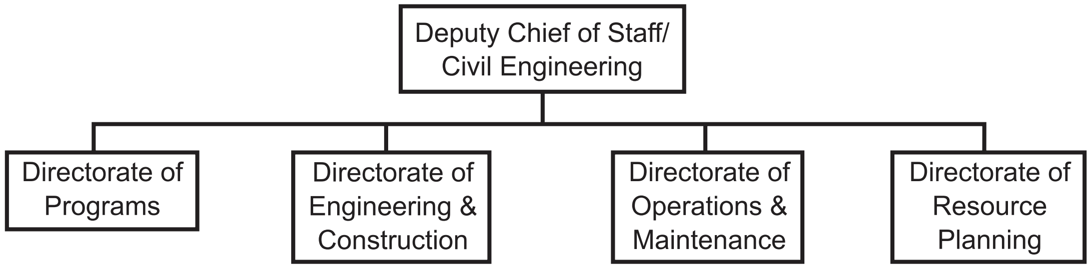
Staff. Among these functions were fire protection, corrosion control, contingency planning, policy, and personnel training for Prime BEEF and RED HORSE, aircraft arresting systems, and applications engineering and investigational engineering programs. As a result of this last reorganization, staffing in the Directorate of Civil Engineering was reduced to approximately 300 persons.[43]

In September 1974, the Environmental Protection Group became the Environmental Planning Division (AF/PREV) under the Directorate of Civil Engineering. The purpose of the new division was to "provide integrated management of environmental protection, master planning for air base development, and land-use planning." The new division contained two branches: Air Base Planning and Development and Environmental Policy and Assessment.[44] This reorganization was a milestone and the first major step for the re-creation and importance of air base facility planning in a new era of environmental concerns expressed in part by the National Environmental Policy Act of 1969 as "all agencies of the Federal Government shall—(A) utilize a systematic, interdisciplinary approach which will insure the integrated use of the natural and social sciences and the environmental design arts in planning and decision-making which may have an impact of man's environment."[45] Up until the time of the Air Staff reorganization of September 1974, this aspect of the law was not widely or fully understood to require implementing actions focused on integrated systematic interdisciplinary approach for decision-making as well as environmental protection and quality criteria.

Major Command Civil Engineering Directorates

Civil engineering at the major command level also was reviewed and reorganized to reflect Air Staff changes. A standard staff organization for civil engineering at the major command level was established in AFR 23-4 revised June 1965 based on a recommendation from the Directorate of Manpower and Organization. Brig. Gen. Oran O. Price commented, after reviewing the existing civil engineering structure in the major commands, "It is like 15 doctors performing an appendectomy in five different parts of the hospital with 10 of the doctors identifying the operation by various names." AFR 23-4 was revised after soliciting comments from the major commands, regional civil engineer offices, and Air Staff divisions. The new structure eliminated confusion over assignments and responsibilities in major commands, facilitated communication among major commands, and ensured effective and efficient staff performance through consolidation of similar activities and responsibilities.[46]

Figure 3.4 Major Command Civil Engineer Staff Organization, 1965



Source: AFR 23-4, "Civil Engineer Staff Organization," June 1965.

Under the standard organizational structure, the Deputy Chief of Staff Civil Engineering led the organization under the command element. The command civil engineering organization was responsible for base facilities planning and programming for active and proposed missions; engineering, design, construction, repair, and alterations of facilities funded through all sources; operation and maintenance of bases; real estate activities; fire protection; and, procedures and resources planning for effective major command mission support. The Deputy Chief of Staff, Civil Engineering oversaw four directorates: Programs, Engineering and Construction, Operations and Maintenance, and Resources Planning. Fire Protection and Utilities Divisions were under the Directorate of Operations and Maintenance (Figure 3.4).[47] This organizational structure was reconfirmed in 1973.[48]

The Continued Drive for Professional Development

All Air Force civil engineers were encouraged to keep abreast of changes in technology, especially construction technology, in order to remain responsive to the needs of the Air Force mission and to maintain Air Force real property assets on bases. General Minton identified three key skills necessary for the success of an Air Force engineer: "professional competence, keen managerial ability, and effective salesmanship."[49] For General Minton, professional competence extended beyond increased engineering knowledge and technical ability to a commitment to engineering as a profession and active participation in professional engineering activities. Management ability encompassed effective oversight of personnel, facilities, and budgets for the operation and maintenance of Air Force real property assets. General Minton described salesmanship as the ability to chart a course of action based on good engineering practice and to convince Air Force superiors of the soundness of the course.[50]

The professional development program extended to many areas. Education and training were key elements of the program and included formal degree programs, training with industry and correspondence courses. General Minton viewed engineering registration and specialized certification as important tools for promoting and maintaining professionalism, directing engineers "I want it [the professional certificate] right there behind your desk, so when somebody is sitting there talking to you, they will see that certificate and any others you have."[51] General Minton convinced the National Society of Professional Engineers to accept engineering experience in the military as credit toward registration as a Professional Engineer. He also supported expanded educational opportunities at the civil engineering school at Wright-Patterson AFB, Ohio.[52] In addition, he created a civilian advisory committee to enhance the proficiency and reputation of Air Force civil engineers. The committee formed groups on electronic data processing, education, professionalism, technical operations, and public relations to discuss and analyze current trends.[53]

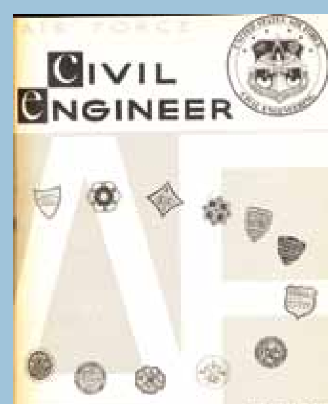
One goal of the professional development program was the cost-effective use of professional skills within the Air Force. General Minton argued that, wherever possible, in-house engineering skills should be used to the maximum and wrote,

> Many relatively minor engineering studies, estimates and designs are all too frequently being accomplished by contract. These include such things as electrical power studies, fuel conversion analyses, building relocation projects, smaller drainage projects and the like. The evidence is clear that a larger portion of our engineering and design work can and should be done in-house….The result will be an upgrading of our over-all professional capability as well as better maintenance, improved accomplishment of O&M projects, better surveillance of major construction, and a saving in resources which can then be applied to other pressing needs. Where we have good engineering capability, let's use it prudently and fully. Where we don't have a minimum level, let's develop it as fast as we can.[54]

Using in-house engineering capabilities as opposed to engineering contracts was also stressed by General Curtin when he became director of civil engineering.[55] By 1967, in-house design capability in civil engineering was at a high level. General Curtin reported that "we are designing in-house over 75 percent of our minor construction, repair and other projects under Air Force cognizance. This means that we finally have in-being the strong engineering backbone we must have to effectively carry out our other day-to-day responsibilities."[56]

The professional development program also stressed professional publications and presentations. The regular publication of the professional journal, *Air Force Civil Engineer,* which debuted in February 1960, was a direct result of this emphasis.[57] General Minton and succeeding directors continued the annual meeting for senior Air Force civil engineers, known as the World-wide conference. These conferences were a way to disseminate policies and plans, as well as to share ideas and to discuss challenges faced by major commands and bases.

Civil Engineer Professional Publication



A new publication entitled *Air Force Civil Engineer* debuted on February 1, 1960.[58] Published by the Civil Engineering Center of the Air Force Institute of Technology at Wright-Patterson AFB, the inaugural issue contained 32 pages. Five thousand copies were distributed among 100,700 personnel assigned to Air Force civil engineering activities.[59] The new periodical was designed to be the equivalent of other military engineering journals with the broader mission of promoting increased professionalism and facilitating communication among civil engineers at the director's office, major commands, and the bases. The purpose of the new magazine, General Minton wrote in the inaugural issue, was "to provide a medium of exchange of professional ideas and information which will result in a more effective civil engineering function in the Air Force."[60] General Minton wanted a journal that would encourage civil engineers to seek professional registration, to serve as a forum to share management improvement ideas, and to promote Air Force engineering achievements and challenges.[61]

The magazine was published four times per year at Wright-Patterson AFB. One notable feature of the magazine was the use of color introduced in the November 1961 issue.[62] General Minton recalled, "It was an OSD [Office of Secretary of Defense] policy that there would be no color in publications such as that. Colonel [Wallace "Wally"] Grubbs, [who was General Minton's Executive] made it part of the professional development program and got approval to publish

continued

Civil Engineer Professional Publication *continued*
in color. We had a drawing of a heat plant that required some way to illustrate the difference between hot and cold water and steam. He went over and talked to the right people in the right way and in about 24 hours we got authority to use color."[63] Color was used in illustrations and to add interest to typefaces and page layouts.

The magazine's first editor was a civilian, Graham T. Horton. In 1962, General Minton hired Steve Canton, a professional editor. Canton's first assignment was to travel to Homestead AFB to cover the Air Force buildup prior to the Cuban missile crisis. At one time, the magazine employed six professionals, including a creative art director. Subsequent editors included George K. Dimitroff (1967-1980), H. Perry Sullivan (1982-86, 1988-95), Letha Cozert (1998-2003), and Teresa Hood (2003-present).

From the first, General Minton encouraged authorship of articles and gained sponsorship of an award for the best article published each year. The yearly award was named in his honor.[64] Between 1960 and 1972, 52 issues of the *Air Force Civil Engineer* published 599 technical articles written by Air Force civil engineers, both military and civilians.[65]

Throughout the years, the magazine has changed its name and format several times. In August 1975, the magazine's name became the *Engineering and Services Quarterly* following the merger of Services and Civil Engineering. Publication of the quarterly magazine ceased in 1986 during a period of cost reduction. The Air Force Engineering and Services Center began to publish a modest newsletter in August 1988. This newsletter initially was titled the *Engineering and Services Update*, and later the *CE Update*. In April 1993, the *Air Force Civil Engineer* magazine debuted. Full color illustrations were introduced in summer 1995. In 2007, the first-ever Almanac issue was released. This annual publication quickly became a useful reference tool for civil engineers throughout the Air Force.[66]

General Minton and succeeding directors of Civil Engineering advocated strongly for civil engineers to join national engineering groups, such as SAME. This organization served as an information forum among engineers from all U.S. Armed Forces. General Minton became the president of SAME in 1960. The presidency of the organization typically rotated among engineers from the Air Force, Army, and Navy. One of General Minton's stated objectives as president was to encourage younger civil engineers to join and to participate actively in the organization either through local chapters or on the national level.[67]

The professional development program was strongly supported by Generals Curtin and Goddard, the succeeding Directors of Civil Engineering. General Curtin urged all Air Force civil engineers to pursue professional advancement through education, professional registration, and participation in local and national professional societies.[68] General Curtin also issued ten commandments for job performance. General Goddard recommended that, in addition to professional registration, all civil engineers undertake independent study in both technical specialties and management, as well as participate in professional societies, publish in the field, and take advantage of formal and informal educational opportunities, such as seminars and correspondence courses.[69] These activities were necessary to keep civil engineers' skill sets current with changing technologies in the field of engineering, and personnel and project management.

Maj. John J. Lieb, who served as the Control Center Chief in the 3201st Civil Engineer Group at Eglin AFB, Florida, summarized the importance of professional registration:

Our Ten Commandments of Job Performance

1. We will produce effective and fully useful work in the first instance.
2. We will call upon our experience and apply the test of logic and common sense where judgment is needed.
3. We will accept full responsibility for our work and its accomplishment without flaw.
4. We will eliminate any shortcomings in "communication" by correlating our work with others concerned.
5. We will not accept substandard work from others and we will help others to eliminate substandard work.
6. We will advise our superiors of any substandard work coming under or emanating from our control.
7. We will constantly strive to improve the quality of our work.
8. We will evolve faster means to eliminate defects in our work.
9. We will hold our heads high as we leave work each evening knowing that we have done our very best.
10. We CAN DO and WILL DO.[70]

> Registration and professional prestige are synonymous. It gives the engineer a distinction; it gives evidence of ability by certifying an individual's competence according to a recognized standard…We, as Civil Engineers, provide, operate and maintain Air Force facilities, and our success, to a great extent depends upon our competence. We are, in fact, guardians of life, health and property at our bases. The public expects a trusted profession to maintain high standards of qualifications and to clear its ranks of those who do not meet the standards. No profession can gain respect unless its minimum standard is high. Registration provides the means to reach this goal. We should not accept a lesser goal, but be leaders in attaining it.[71]

Emphasis on professionalism in civil engineering continued through the early 1970s. In 1971, Air Force civil engineers were encouraged to have PRIDE, or Professional Responsibility in Daily Engineering.[72]

The Engineer-Manager

During the 1960s, the description "engineer-manager" came to characterize the job of the Air Force civil engineer. The engineer-manager not only maintained technical engineer proficiency, but also acquired managerial skills to coordinate teams on major projects or to manage air bases with the size and complexity of small cities.[73] During the 1960s and early 1970s, Air Force civil engineers implemented new management controls to increase operational efficiencies, to improve personnel productivity and quality, and to track and control costs. Management principles drawn from the private sector were applied to the Air Force civil engineering organization. As expressed by General Minton, "The well-rounded Air Force Civil Engineer must be a good executive and a good manager. As an engineer, he has a professional responsibility for keeping himself informed on the latest technological developments—new products, processes, and scientific tools. As an executive, he has an associated responsibility for keeping himself informed on the latest development in the management sciences."[74]

In 1961, a new cost accounting system was adopted by the Air Defense Command to meet the day-to-day need for realistic cost information at all levels of civil engineering. The complexity of base management, which included operations and maintenance for a wide variety of facilities at a diversity of bases, required an accessible and accurate system to track costs. Development of the system began in late 1959 and was field tested at Tyndall AFB, Florida. The system provided the capability to capture new and detailed cost data at base level and to compile data appropriate for reporting to headquarters.[75]

In 1962, the Critical Path Method (CPM) was introduced as a scheduling tool that incorporated graphs and diagrams illustrating project planning, scheduling, and time/resources relationships.[76] CPM was a method of applying a network scheduling technique to projects. The technique divided a project into major tasks, i.e., planning, scheduling, and time/resources relationships. Each task was subdivided into the actions, activities, events required to accomplish the task. Charting these steps assisted in overall project planning and in organizing personnel, materials, and scheduling. While construction was a major area of application for CPM, the technique also held promise to support contract schedules, critical operations within the organization, and assessing progress status.[77] During 1962, Directorate of Civil Engineering personnel were briefed on CPM and the related Navy-developed Program Evaluation and Review Technique (PERT). Briefings were also given to civil engineering personnel at the Air Force Regional Civil Engineer Offices and at major commands.[78]

In March 1963, CPM was adopted by the North Pacific Air Force Regional Civil Engineer office. By March 1965, CPM was employed on 66 projects, totaling over $15 million in new construction.[79] By 1966, CPM was applied as a management tool to assist planning on the base level and at headquarters. The method was used in military construction projects and maintenance operations.[80] In July 1967, CPM was used to support planning to implement the reorganization of Directorate of Civil Engineering. CPM came to stand for Complete Project Management.[81]

General Curtin introduced several programs to increase operational efficiencies and manpower productivity through improved management in response to declining budgets. Austere budgets for stateside bases became the norm during the mid-1960s, as defense resources were directed to the conflict in Southeast Asia. Between FY65 and FY68, funding directed for activities in Southeast Asia increased fourfold. In that same period, funds available for facility maintenance by contractors at the stateside bases decreased by 60 percent. In addition, funds available for supply procurements for in-house maintenance and repair also decreased.

One program initiated under General Curtin and continued by General Goddard was BALANCE, which stood for Basic and Logically Applied Norms-Civil Engineering.[82] The goal of the program was to examine *basic* civil engineering responsibilities and *logically* determine immediate areas for emphasis, then *apply* them through "the expression of *norms* for evaluating *civil engineering* effectiveness."[83] Air Force civil engineers operated under approximately 185 manuals, regulations, and pamphlets, in addition to Air Force procurement, supply, and other rules. Questions arose on how to determine acceptable performance levels for civil engineers in light of the large volume of technical and substantive requirements. The BALANCE program was initiated as a self-evaluation process tailored to the civil engineering organization in all major commands. Instead of analyzing the missions of major command, BALANCE scrutinized the civil engineering functions necessary to support those missions. Three objectives were derived:

1. Provide major commands with a self-evaluating and uniform measuring technique to assess effectiveness of civil engineering.
2. Isolate problem areas and channel management effort.
3. Improve communications between Headquarters U.S. Air Force and the major commands.[84]

The program developers identified 26 areas for evaluation. The evaluation indicators were modified over time to emphasize areas of Air Staff concern. BALANCE teams comprising senior members of the Directorate of Civil Engineering visited major commands. The first BALANCE team was led by Mr. Rufus "Davey" Crockett, Associate Deputy Director of Civil Engineering. By 1968, the program was expanded to encompass all levels of the civil engineering organization and management by results was incorporated into AFR 85-21.[85]

A corollary program to BALANCE was Program Evaluation and Assistance-Civil Engineering (PEACE). This program was conceived in November 1967 as a way to examine base-level implementation of revised regulations, new programs, and new directives issued by the Directorate of Civil Engineering. In January 1968, the first PEACE team visited Bolling AFB, D.C., and Andrews AFB, Maryland. PEACE teams were handpicked by the Director of Civil Engineering and comprised personnel with hands-on experience from all divisions in the directorate in grades ranging from master sergeant through colonel. The PEACE team sought to observe the real working conditions on the bases with a minimum of disruption to base day-to-day activities. Another major objective was to strengthen communication between directorate personnel and base-level personnel. During the two-day visit, PEACE team members met with their base counterparts. At the end of the visit, the results and observations of the PEACE team were delivered orally to the base civil engineer and individual organization areas. During 1968-1969, 22 bases were visited, representing a sample of approximately 10 percent of major Air Force installations. The overall findings of the PEACE team identified areas for improvement both in base level procedures and through revised regulations.[86]

Beginning in FY69, General Goddard established a Management Review Panel that met in a Management Review Center and comprised selected leaders from throughout the organization. This group provided general guidance for evaluating all elements of the ongoing comprehensive management improvement program, including BALANCE, PEACE, automation efforts, and total programming. This group also assisted in establishing annual Civil Engineering objectives and developing a management review program.[87] For FY69, General Goddard and the Management Review Panel defined 13 major civil engineering objectives. These broad-based policy and performance objectives addressed the entire spectrum of civil engineering resources management. The objectives were a major item on the agenda of the December 1968 World-wide conference and were published in the *Air Force Civil Engineer* magazine.[88]

In January FY75, the Directorate of Civil Engineering directed that each major command and base civil engineering organization establish a Management by Objectives program. The Management by Objectives program was designed as a decentralized management tool tailored by civil engineer managers at each level to their unique concerns, challenges, organizations, and missions. All objectives and tracking were conducted at the organizational level and oriented to the current needs and concerns of the organization. Objectives were not, however, established by headquarters and no formal reporting

FY69 Civil Engineering Objectives

1. Work Force Productivity: Increase the productivity and effectiveness of the work force by 15 percent.
2. Inventory Use and Condition: Obtain a credible posture on the use, condition, aggressive disposal and proper reporting of our inventory.
3. Supply Support: Determine the dollar amount of locally purchased supplies required to keep our work force gainfully employed and see that the Air Force Operations and Maintenance budget and supply system provide this amount.
4. Annual MCP Level: To attain and maintain an annual MCP level of $750 million for the next five years.
5. Projects by Contract-EE520: To determine the optimum annual level of funding for projects by contract to adequately complement the in-house work force capability in accomplishment of the maintenance and repair requirement and to reduce the backlog of maintenance and repair to an acceptable level within the next five years.
6. Family Housing New Construction: Increase the level of new family housing construction to 10,000 units per year beginning with the FY70 Military Construction Program, and continuing for the next 10 years.

continued

FY69 Civil Engineering Objectives *continued*

7. Modernization of Existing Family Housing Inventory: Increase the level of funding for improvement to existing family housing units to approximately $20 million per year beginning FY70 MCP and continue this level until all existing inventory is brought to a level of comparability.
8. RED HORSE Force Level: Retain on a permanent basis a RED HORSE force level of approximately 3,000.
9. Civil Engineer Research and Development: Recognize and program Civil Engineer Research and Development requirements within the Civil Engineering Technology Program Element established in FY70 and expand the applications engineering capability to take greater advantage of the experience of industry and other Government agencies.
10. Civil Engineering Vehicular Equipment: Obtain urgently needed Civil Engineering vehicle replacements and implement a multi-year modernization program.
11. Professional Engineer Force: To maintain a viable, efficient and mobile organic Professional Engineer Force (GS-9 and above) capable of supporting the Air Force worldwide mission in peace and war through a variety of work accomplishments that will assure top proficiency.
12. Fire Prevention: Reduce the dollar loss of the Air Force physical plant due to fire and the number of incidents which could lead to fire loss to a level not in excess of either 80 percent of the past three years average or 95 percent of the past year's experience, whichever is less.
13. Design and Construction: Reduce in FY70 the design execution time and cost by 25 percent and the construction execution time and surveillance cost by 10 percent.[89]

was required. The sole program requirements were that the Management by Objectives program be formal and visible.[90]

The Directorate of Civil Engineering introduced the Standard Base Civil Engineer Management Review Program to assist base civil engineers in utilizing base data generated by studies and compiled in automated data bases. The purpose of the program was to provide the base civil engineer with the basic data that described "the status of his programs, personnel, finances, workload, vehicles, engineering design and construction so that he can make the best decisions based on the best information available." The program also provided standards and tables to facilitate self-administered base evaluations. The directorate further generated annual management targets. By late 1969, the first materials were distributed to the bases through each major command. The Management Review Program was designed to complement the BALANCE program. The program was described in AFR 85-20 published in July 1969.[91] In early 1971, AFM 85-38 entitled *Civil Engineer Management Review* was published. This manual presented the basic concept and process for base civil engineer management review, self-evaluation, and problem solving, as well as provided specific guidance for the Industrial Engineering activity.[92]

In October 1969, General Goddard renamed the PEACE Team the Management Review Team. The team's function was to evaluate the capability and performance of base civil engineering and supporting organizations. Quarterly base-level reviews and evaluations of civil engineer operations and management were proposed. PEACE teams comprised representatives from each division.[93] By May 1970, the Management Review Team had visited four bases.[94] The 11-person Management Review Team was re-chartered in early FY71. Its mandate called for conducting total performance evaluations of selected base civil engineering organizations. Of the 17 base visits scheduled during FY71, four visits were completed between October and November 1970.[95] The team's purpose was to evaluate use and effectiveness of directives, systems, and programs; resource capability of base civil engineer organizations; support provided to base civil engineers; and major problems identified in the field.[96]

During the late 1960s, efforts also were made to impose greater controls on the programming process for new construction, minor construction and repair under $200,000, and operation and maintenance funds. The emphasis on programming was driven, in part, by new funding processes instituted by the Office of the Secretary of Defense. During the early 1960s, the MCP operated on a five-year cycle with operations and maintenance funds allocated on a yearly basis. In fall 1963, General Goddard, then command civil engineer of AFLC, instituted the concept of total programming, which incorporated a five-year planning cycle for operations and maintenance funds. In 1964, the base civil engineer at Wright-Patterson AFB, Ohio, was assigned the task to test the program and to develop procedures to prepare and to manage the five-year operations and maintenance phase of the program.[97]

In October 1966, Project Top Theme was initiated at the Air Staff to improve Air Force civil engineering programming efforts. By late 1967, the concept had evolved into total programming.[98] Total programming was designed to maximize construction and maintenance from available dollars. As explained by General Goddard,

> Total programming exemplifies an integrated systems approach to comprehensive work planning and resource utilization…. It is having an enormous impact on our base-level operations...for without adequate determinations of our total work requirements, our resources and their planned use, and our current and projected deficiencies and limitations, we cannot adequately define our current total management role, much less perform it.[99]

Total programming, simply stated, was single point programming. The process consolidated the analysis of relevant data on facility requirements and available funding to prioritize projects for execution during a one to five year period. Implementation of total programming required five steps:

1. Identifying work and resource requirements
2. Estimating resources, including labor hours, material dollars, and contract dollars
3. Developing the program for new facilities or maintenance and repair projects
4. Gaining program approval
5. Accomplishing the work as funded[100]

The initial step of total programming required field verification and condition assessments of buildings, structure, and infrastructure on bases. This verification process further assisted in identifying assets in need of repair, replacement, modernization, or upgrading. AFLC tested a total facility study in 1966 at Hill AFB, Utah, then required implementation of the procedure on all its bases in September 1966.[101] By 1968, the process was in use Air Force-wide. Engineers examined the structural sufficiency and economic viability of existing facilities to determine their condition and capacities. Corrective actions to remediate civil engineering concerns also were identified. Project documentation files, known as "jacket files," were developed for each major facility and contained the engineering evaluation and all documents pertaining to proposed or completed work. Responsibility for single-point programming was assigned at each base, major command, and directorate of civil engineering. All facility programs were reviewed by the same office under a single manager to improve coordination of the military construction program, operations and maintenance, and non-appropriated funds projects.[102]

By 1970, an automated version of total programming was under development.[103] The automated program was implemented in 1972.[104] During 1973, the Air Staff conducted an in-depth study of total programming to determine if the concept generated data for effective resource management commensurate with the level of effort expended. Feedback from the major commands, bases, and the Inspector General indicated that, in many instances, aspects of the total programming program were not working as effectively as originally intended.[105] By December 1975, total programming was eliminated from base-level procedures and AFR 85-1. Total programming was found not to be cost effective since few automated products were used widely and little of the work identified through total programming was accomplished.[106]

Other management initiatives addressed improving worker productivity and instituting quality control and evaluation functions. By 1967, quality control program guidelines were published in AFM 85-1, paragraph 4-7. The general guidelines directed monthly random inspections of in-service work managed through the base work control center, as well as bi-annual inspection of all work center management activities. In implementing these guidelines, AFLC noted problems in the execution of the quality control program. Air Staff, which was committed to the quality control program, responded with a review of the entire program. The resulting study revealed a wide variety of problems, including lack of support for the program, ill-defined credentials for inspectors, problems in sampling methods, and a lack of standardized checklists to assure consistent data collection. AFLC redesigned the program, standardized sampling methods and reporting requirements, and tested the program from July through December 1969.[107] The quality control program continued to be supported by the Air Staff through the early 1970s.[108]

Personnel Allocations and Project Prime BEEF

Manpower presented a continual challenge throughout the Air Force civil engineer organization. Manpower reviews, known as blue suit reviews by the 1990s, were conducted periodically to evaluate total personnel numbers required to support war fighting scenarios defined by the DoD. Personnel on active duty, in the Air National Guard and in the Air Force Reserves were included in manpower totals. The reviews determined strength in specific categories of positions as defined under Air Force Specialty Codes (AFSC) and Unit Type Codes (UTC) for contingency operations. The ratio and mix of officers and enlisted personnel also were assessed. Such reviews provided the Air Force with a firm grasp of the classifications of available military personnel. These evaluations typically resulted in repositioning military personnel, redefining personnel responsibilities, and often eliminating unneeded or dead-end career fields.

During the early 1960s, Air Force civil engineer personnel numbered 100,000, including 2,000 officers, 41,000 Airmen, and 57,000 civilians.[109] Discussions were initiated to revise the AFSCs established in 1957, which were becoming outdated and did not reflect the current roles of Air Force civil engineers.[110] Each major command differed in organization, as did the mix of military and civilian personnel within each command.[111] In addition, while the overall number of officers stood at 93 percent of requirements, a severe imbalance existed between senior and junior officers. The number of lieutenants represented 165 percent of requirements, while the number of captains filled 50 percent of requirements.[112]

Maj. Gen. Robert H. Curtin was Director of Civil Engineering at the time. As he told the story,

> The Air Force Organization and Manpower office raised the question regarding the size and organization of our force. [Maj. Gen.] Benjamin Davis brought it to me. I'd never really thought about it in the terms he pointed out. He said, "We have to do something, or we're just going to lose a lot of the military because of the demands on them."…It was mainly related to the question of why did we have "X" number of military on one base and "Y" number of military on another. It didn't seem to relate to the flying units. The idea of Prime BEEF was to establish some organization and standardization of things and recognition of the fact that there were a certain number of people required to do the jobs that we did. And we had to create a closer relationship with the flying capabilities, or the wartime capabilities,

> if you will. That's when we started looking at how many people do you need over here, really, and who's going to set up the camps. We did a lot of planning on how to deploy.[113]

In December 1963, the Civil Engineering Manpower Study Group was formed. Representatives from Civilian and Military Personnel were added to the group when the goal became to manage total manpower requirements for civil engineering personnel. The purpose of the group was to "determine the distribution, alignment, reliability, credibility, and skills required in the Civil Engineering Manpower resource to perform essential Civil Engineer functions in support of the Air Force mission." The group also worked within DoD and Air Force manpower guidelines, including AFM 26-10 *Manpower Utilization* that stated that military personnel would be used in direct combat situations, while civilians would be used in indirect combat support functions.[114]

The study group addressed questions raised by the U.S. Congress in regards to the military manpower of the Air Force civil engineers. According to Lt. Col. (later Brig. Gen.) William T. Meredith, who served as Chairman of the study group, Brig. Gen. Oran Price, Deputy Director for Civil Engineering Operations, Air Staff, approached him with the following assignment: "Congress has raised the question, probably caused by the unions, why the Air Force has 44,000 blue suit troops in civil engineering, predominantly in Strategic Air Command, instead of those being civilian spaces. Two questions have got to be answered. Do we need combat support, or don't we? And if we do, what do we need?" General Price assigned Colonel Meredith the tasks of forming a study group and presenting the results for the U.S. Congress. He was given an 18 month deadline.[115]

The study group combined the questions into one: "Is the present Civil Engineer Force properly aligned and is the distribution of this resource adequate to perform the essential real property facility functions in support of the Air Force mission today and tomorrow?" Part of the study included a one-week visit to the Department of Civil Engineering Training at Sheppard AFB, Texas. The object of the visit was to gather information from major commands related to their specific procedures.[116]

Col. William T. Meredith

The Formal Report of the Civil Engineering Manpower Study Group defined five key issues within the existing Air Force structure in 1963.[117] These issues showed:

1. No appreciable rapid mobile response capability for Tactical Air, Special Air Warfare, or contingencies…
2. The civilian/military mix developed without any uniformity between major commands, or between similar type installations within the same major command…
3. Little or no relationship between the skills identified for military authorizations and the tasks which this 'hard core' resource must perform in its combat support role…
4. The career progression in many areas was inadequate…
5. The skill level requirements in many cases were not adequate to meet the skill requirements of the job…[118]

The Air Force was without reliable dedicated wartime or emergency construction capability based on the 1957 DoD Directive 1315.6 that defined the separate roles of the Air Force and the Army in overseas contingency operations. Recent experiences, such as the 1961 Berlin crisis, the Cuban Missile crisis, and the early years of the Air Force involvement in Southeast Asia, demonstrated to Air Force civil engineers that "there was insufficient military capability to provide continuity of essential services under emergency conditions."[119]

Changes in weapons systems and the role of civil engineers were major factors in the issue of manpower allocations. "The role of the civil engineer has changed to one of Direct Combat Support. For the first time, major weapons systems became dependent of Civil Engineering support to get off the ground or to exist in their ground environment…The complexity of our facilities, as they relate to the weapons systems, requires maximum assurance of continuing operations."[120] The report marked the official recognition of the significant changes that had occurred in the late 1950s and early 1960s. Official recognition of these changes further confirmed the appropriateness of General Minton's push for professionalism and the critical importance of civil engineers in support of new CONUS weapons systems, such as missiles, and the defensive systems, Semi-Automated Ground Environment (SAGE) and Ballistic Missile Early Warning System (BMEWS). The study also acknowledged that the skill sets of military personnel must include those required for combat support and not be limited to the skills for maintaining peacetime bases.[121]

General Meredith recalled how the results of the study group were formulated,

> we began studying and considering what kind of teams we needed to carry out the scenarios in those postulates. Like major base support, regardless of whether it was combat or not, i.e., supply or whatever. Then we went through the makeup of the force—carpenters, plumbers, power production, firefighters, etc., and we set up a scale. We said for a contingency team, for instance, we would need about a 60-man team. We had an M-type team for missiles that was a 60-man team. An R team was for recovery. We took those numbers and overlaid them on the manpower documents, base by base. Jeanne Holm, Ken Jacobson, and I sat down and in those days, you'll remember, Xerox had just started. We didn't have computers. We sat there for over 72 hours. We only broke enough to get a bite to eat and go to the bathroom. We took the Air Force manning document, every damned page in it, and we went through and made a separate sheet for each one of those bases, indexed it back to that manning document, put the revised manpower onto it, including every slot as to what it should be—military or civilian, what the grade should be, and what the skill level should be. After we finished, we tidied it up. We came up with, as I recall, a requirement of 37,000 or something like that.[122]

Figure 3.5 Civil Engineering Air Force Specialty Codes - 1964

MECHANICAL/ELECTRICAL
541X0 Missile Facilities
542X0 Electrician
542X1 Electric Power Line
543X0 Electrical Power Production
544X0 Cryogenic Fluids Production
545X0 Refrigeration & A/C
546X0 Liquid Fuels System Maint
547X0 Heating System

SANITATION
563X0 Water & Waste Processing
566X0 Engineering Entomology

STRUCTURAL/PAVEMENTS
551X0 Pavement Maintenance
551X1 Construction Equipment
552X0 Carpentry
552X3 Masonry
552X4 Protective Coating
552X5 Plumbing
553X0 Site Development Specialist
554X0 Cost and Real Property
555X0 General Maintenance Mechanic
556X0 Work Control

FIRE PROTECTION
571X0 Fire Protection

Source: Files of AFCEC History Office, Tyndall AFB, Florida.

The results of the study group had far reaching effects on military and civilian Air Force civil engineer personnel allocations. The study group demonstrated that restructuring military and civilian staffing of the Air Force civil engineering organization was necessary in order to "fulfill adequately its direct combat support role." Skill specialties were redefined and revised as a result of the study. AFM 39-1 issued in September 1964 explained the new structure (Figure 3.5). One result of the restructuring was to establish specific areas of training to build skill sets necessary for disaster and emergency recovery and combat missions. According to Lieutenant Colonel Meredith in a 1964 article in *Air Force Civil Engineer* magazine, "often, prior to the career structure revision, there was no relationship between the skills identified for military authorizations and the skills needed for direct combat support."[123]

In addition to supporting a focused training element, the restructuring also abolished dead-end career tracks, thus creating opportunities for promotion within specialized areas of the civil engineer career structure. The overall career structure was divided into four areas: Mechanical-Electrical, Structural-Pavement, Sanitation, and Fire Protection and encompassed 21 career ladders and ten superintendent positions.[124]

The most significant result of the manpower study was the creation of the Base Engineer Emergency Forces, known as Prime BEEF. The name was coined by General Price. According to General Meredith,

> I said to General Price, "We've got to come up with a name for this thing." He said, "I've been thinking about it." And he's the man who named Prime BEEF. He said, "Prime BEEF." I said, "Tell me what it stands for." He said, "Prime, meaning the first force, *prima*. And BEEF—base engineer emergency force." And that's where it stuck.[125]

The 1964 *Formal Report of the Civil Engineering Manpower Study Group* explained the three military missions of Prime BEEF:

1. A minimum force of military civil engineers must be maintained at each air base, missile squadron/wing, depot or station, world-wide to maintain essential O&M services during and immediately following enemy attack, periods of imminent attack, major fires, floods and other emergency conditions.
2. A force of military civil engineers must be attached to each flying unit which is designated for performance of emergency missions from an unoccupied, bare or dispersed operating base. This force of civil engineers must maintain its integrity and be prepared to proceed or accompany the flying unit for which it will provide essential O&M services under emergency conditions.
3. A force of Military Civil Engineers must be trained in pioneer environments and be prepared to participate in unforeseen Contingencies and Special Air Warfare operations such as occurred during the Berlin, Cuba, and Southeast Asia crises.[126]

Originally, Prime BEEF was organized with two major operational concepts: Base Engineer Emergency Team Concept (BEET) and Mobile Combat Support Team Concept (MCST).[127] By 1965, Prime BEEF comprised four groups: BEEF-R, Recovery Team; BEEF-C, Contingency Team; BEEF-F, Flyaway Team; and BEEF-M, Missile Team.[128] The Recovery Team fulfilled the emergency team concept and a recovery team was formed from military personnel stationed at each CONUS and overseas base. Recovery Teams ensured base maintenance and operations during, and immediately following, an attack, major emergency, or natural disaster. Recovery teams implemented the base disaster recovery plan and provided the following comprehensive services: work control, structural and crash fire protection, water supply and distribution, sewage collection and disposal, liquid fuels system, electric power production and distribution, refrigeration, debris and snow removal, pavements repair, and structural damage control. Recovery teams, working in two shifts, were responsible for maintaining base operations for up to 36 hours.[129]

Mobility combat support was provided by the other three teams. The Contingency Team was created to handle unanticipated exigencies and special wartime air operations to support Air Force missions world-wide. Contingency Teams were not assigned to specific air units. Flyaway Teams were attached to air units, typically TAC or Military Air Transport Service (MATS) and were responsible for supporting those units. Members of the Contingency Team and the Flyaway Team deployed rapidly. As a result, the teams maintained ready kits that included tools, suitable clothing, and personal records.

Table 3.1 Prime BEEF teams as of 1973

Name	Number of Teams	Average Team Size in Personnel	Total Personnel
BEEF-R Teams			
Postured	117	161	18,868
Sites, Stations	- -	- -	5,784
BEEF-C Teams	46	60	2,760
BEEF-F Teams	22	60	1,320
BEEF-M Teams	10	97	974
BEEF-LS Team	1	77	77
BEEF-E Teams	15	40	600*
Totals	211	not applicable	29,783

** Personnel came from existing R teams, not included in total.*
Source: Maj. Hubert S. Nethercot, "Prime BEEF Base Recovery Forces," Research Study submitted to the Faculty of Air Command and Staff College, Air University, Maxwell AFB, Alabama, 1973, 33.

Both the Contingency Team and the Flyaway Team could be activated as a unit or as a partial unit. The Missile Team was created to offer support to the missile maintenance organization, particularly in projects exceeding daily missile upkeep. The Missile Team also provided depot level support for real property.[130]

The Prime BEEF program was initiated through a September 27, 1964 letter to all major commands on the subject of "Civil Engineer Military Manpower Requirements from the Directorate of Civil Engineering." The schedule proposed for implementing Prime BEEF was April 1965, but the program took years to implement. The U.S. Congress approved the program in October 1964.[131] By 1965, 70 BEEF-C and BEEF-F teams were formed. General Curtin opined that "full realization of the program will require 4 to 5 years."[132]

The ongoing conflict in South Vietnam provided an impetus for rapid implementation of project Prime BEEF. As Brigadier General Meredith recalled, "[Brig. Gen.] Oran Price called me late one night. The day before we had been sitting in his office talking, and he was saying how well this thing [Prime BEEF] was structured. He said, 'My God, we need something to happen.' He called me that night and he said, 'Bien Hoa [in Vietnam] has just been hit. Deploy three teams.'" Three Prime BEEF teams deployed to South Vietnam in August 1965.[133] (Prime BEEF deployments are discussed in greater detail below).

Prime BEEF continued to evolve. By the mid-1960s, another mobile Prime BEEF team (BEEF-LS) was added to meet the logistic support requirements of AFLC.[134] By 1970, the engineering assistance team, or E-team, was introduced. The E-team comprised engineers and technicians representing special functions, such as master planning, site selection, engineering layout, and design and construction management.[135] By 1973, the Prime BEEF program was 92 percent implemented.[136] Prime BEEF statistics are presented in Table 3.1.

Project Prime BEEF was a major success in realigning Air Force manpower in emergency and contingency situations and expanding the civil engineer role beyond the maintenance and operations functions associated with stateside Air Force bases. In the early years of the program, Mobile Prime BEEF teams were employed widely to support civil engineering activities in South Vietnam. In CONUS, all major Air Force bases had a Prime BEEF Recovery Team trained as first responders in natural disasters. Recovery Teams provided support to their home bases, other Air Force bases and the surrounding community. General Curtin reiterated,

> Prime BEEF is not an exercise directed solely, or even primarily, at sending select military teams to SEA…it is an Air Force-wide program to assure that our total Civil Engineering force is in proper balance and can provide responsive support to all short-term emergencies as well as meet our normal day-to-day needs. Prime BEEF comprises the military manpower base in support of the Civil Engineering function.[138]

Between its implementation in 1964 and 1975, 318 mobile Prime BEEF teams comprising 9,402 military personnel were deployed world-wide. [139] Fifty teams were deployed to the Republic of Vietnam and to Thailand between 1965 and 1968. An additional 13 teams were deployed in 1968 directly to South Korea or in support of missions in South Korea. Other overseas deployments included the civic action program to the Trust Territory of the Pacific Islands and annual maintenance projects in Antarctica. Stateside Prime BEEF deployments occurred following Hurricane Camille, and the 1967 floods in Alaska. Prime BEEF also participated in the Air Force Weapons Laboratory testing programs.[140]

During the late 1960s, job classifications and descriptions for sectors of Air Force civil engineering personnel were realigned. In 1968, new AFSCs for civil engineering officers were published in AFM 36-1, *Officer Classification Manual*. Under the revised officer classification system, base civil engineer and staff engineer classifications were consolidated to enable personnel rotations between base and higher headquarters levels. The AFSCs revised the job qualifications, level of knowledge and experience for the positions. For the first time, a degree in engineering, architecture, agronomy, forestry or graduation from a service academy became a prerequisite for entry into the Air Force civil engineering field.[141]

A program to standardize civilian job descriptions across the Air Force civil engineering organization began during the early 1970s. The purpose of the program was to define civilian, professional, and technical positions critical to the civil engineering mission in the field. Job descriptions were developed to allow officials to assign work within work centers, to ensure that compensation was commensurate with levels of responsibility, and to ensure that work was completed. By 1971, 33 standard base engineering position descriptions were completed, including 11 supervisory and 22 non-supervisory jobs. The draft descriptions were reviewed by the Directorate of Civil Engineering and then submitted to the Directorate of Civilian Personnel for classification; finally, approval was issued by the Directorate of Manpower and Organization.[142]

Between 1970 and 1972, Air Force civil engineering underwent a 20 percent reduction in manpower. In 1968, the civil engineering personnel staffing level stood at approximately 100,000. By 1972, the civil engineer workforce was reduced to 80,000. Despite the reduction in force, Air Force civil engineers met an increasing workload on CONUS bases and overseas.[143]

Palace Blueprint

In 1966, a special study directed by the Air Force Chief of Staff found that personalized career management encouraged long-term staff retention. General Goddard, the Director of Civil Engineering, supported the adoption of personalized career management and worked directly with the Air Force Military Personnel Center (MPC) at Randolph AFB, Texas, to fund two positions to improve career management for civil engineer officers.[144] The resulting program, Palace Blueprint, was introduced officially in October 1969 and was staffed by four officers who matched available assignments in the major commands to the qualifications and interests of civil engineering officers. Originally envisioned as a two-year pilot program, Palace Blueprint was adopted permanently within a year. The program guided career development and coordinated end assignments. The objectives were to establish a career development unit within MPC, to use qualified officers as career counselors, to interface career development into the assignment process, and to assure effective communication among officers, the career development unit, and assignment activities. Officers were supported in planning their civil engineering careers through direct consultation with qualified civil engineers in the career development unit. The ultimate goal was to meet the staffing objectives of the Air Force, while encouraging individual career objectives.[145]

Concrete Youth Program

By the late 1960s, a large number of civil engineers were approaching retirement. Air Force civil engineering faced a pending exodus of corporate knowledge and experience. The Directorate of Civil Engineering responded with "Concrete Youth," a program to train young engineers for the positions about to be vacated. The program recruited recent engineering graduates who were groomed through an intensified development program. The program was designed to enable rapid professional advancement for recent graduates in the civil engineering organization. In addition to addressing the immediate staffing need, the program also significantly improved the ability of the Air Force to compete effectively with private industry and other services for qualified engineers.[146]

Officer Exchange Program

Air Force Civil Engineering had an officer exchange program with the Royal Canadian Air Force in the 1960s. Air Force officers spent three years at the RCAF headquarters working projects with the Continental Air Defense Integration North program. In the 1970s, the exchange program was broadened to include other Services.[147] The Civil Engineering Officer Exchange Program was proposed by the Directorate of Civil Engineering in 1973. The program was developed through an agreement signed by the Army, Navy, and Air Force authorizing the exchange of officers between the services on a one-for-one basis for two-year assignments. The goals of the program were to expose each branch of the military to the civil engineering practices of other branches, to share procedural information, to enhance the professional development of the participants, and to encourage participants to pursue higher positions within their home services. A 1975 article in the *Air Force Civil Engineer* magazine recounted the personal experiences of officers during the early years of the program. Lt. Col. Ronald W. Brass, an Army engineer officer who served with HQ Strategic Air Command at Offutt AFB in Nebraska, reflected positively on his experience in the program. Lt. Col. Brass commented, “My original reservations as to the limit of an exchange officer’s effectiveness, due to the obvious lack of intimate knowledge of the sister service’s procedures and policies, are not valid. The practice of the engineering profession and the principles of management are universal in and out of the government, and a firm background will serve a military engineer well regardless of the arm to which assigned.”[148]

Personnel Firsts

The 1960s and early 1970s was a period of personnel advancements. During the early 1960s, John “Jack” R. Gibbens was promoted to the Senior Executive Service and became the highest ranking civilian in the Directorate of Civil Engineering. After managing the Air Force construction program during the 1950s and early 1960s, Gibbens was appointed as the Associate Deputy Director for Construction in 1962 and served in the position until 1969. He essentially served as the first deputy Air Force civil engineer.[149]

Mr. John R. “Jack” Gibbens Associate Deputy Director for Construction, 1962-1969.

Antarctica Reenlistments

Two members of Prime Beef Team 75 became the first Air Force personnel to reenlist on the continent of Antarctica and at the South Pole. The team was participating in Operation Deep Freeze 69. SSgt. James B. Tarr of the 3020 Civil Engineer Squadron reenlisted on October 28, 1968 in Scott's Hut, a historic building near McMurdo Station. SSgt. Theodore Babin of 2852 Air Base Group, McClellan AFB, California, reenlisted on November 10, 1968. The temperature on that day was -43 degrees Fahrenheit. The ceremony was held outdoors, but the papers had to be signed indoors because the ink froze in the pen.[150]

By the late 1960s, Air Force enlistments and re-enlistments were recorded on almost every continent. In 1968, personnel re-enlisted in the Air Force on the continent of Antarctica for the first time.

Women rose in profile among the engineering force. While they previously worked in administrative positions as secretaries and clerks, civilian women joined the professional engineering ranks during the 1960s. In 1971, 2d Lt. Susanne Ocobock Waylett became the first female military Air Force civil engineer. Air Force regulations and policies were revised and personnel structuring adjusted to reflect the role of women in Air Force civil engineering. In December 1975, the Air Force issued a policy decision to assign women to mobile and recovery Prime BEEF teams; women initially were not assigned to RED HORSE squadrons.[151] RED HORSE squadrons were opened to women on June 8, 1988.[152] Air Force civil engineering recognized the talent and accomplishment of their female civil engineers through career advancement. Susanne Waylett became the first female civil engineer in the Air Force to advance to the rank of colonel and the first female commander of a RED HORSE squadron.

Sue Waylett, First Woman Civil Engineer

2nd Lt. Susanne Ocobock (later Waylett) is welcomed by Maj. Gen. Guy H. Goddard, Director of Civil Engineering, 1971.

Sue Waylett achieved a number of "firsts" throughout her 29-year Air Force career. In 1971, she had the distinction of being the first woman to enter the Air Force Civil Engineering career field. A native of Michigan, Lieutenant Waylett received a Bachelor of Science degree in industrial engineering from the University of Michigan before attending Officer Training School at Lackland AFB, Texas. She was first assigned to Kelly AFB, Texas, where she spent as much time doing public relations as she did working. In fact, the Secretary of the Air Force and Chief of Staff invited her to come to Washington on a public relations recruiting visit. By 1972, she made first lieutenant, and, by 1975, she became captain. Between 1975 and 1979 she served in the Air Force Reserve. She returned to the active duty Air Force in 1979 and was stationed at

continued

Sue Waylett, First Woman Civil Engineer *continued*
Eglin AFB, Florida. In 1983, Captain Waylett advanced to major. The same year, she enrolled at the Wright-Patterson AFB Air Force Institute of Technology in Ohio to complete a master's degree in engineering management. In 1987, Major Waylett traveled to her new assignment in Zweibrucken, Germany, where she became the first female to command a civil engineering squadron. This was not the last first for Major Waylett. In 1992 she returned to America and was stationed at AFCESA, Tyndall AFB, Florida; there she became the first female civil engineer colonel in the Air Force. In 1994, she became the first female commander of the 823d RED HORSE Squadron at Hurlburt Field, Florida. Colonel Waylett led the squadron to Bosnia to build tent cities for the Army in Operation JOINT ENDEAVOR and to Saudi Arabia to build a bare base at Prince Sultan AB. Colonel Waylett continued her service with the Air Force through 2000, serving as the USAFA civil engineer when she retired.[153]

The Civil Engineering Center

The Civil Engineering Center (CEC) was established as a field extension to support the work of the Directorate of Civil Engineering. The organization also played an increasingly important supporting role for managing the bases. The CEC was established on May 15, 1968 to expand on the activities previously assigned to the Civil Engineering Construction Operations Group (CECOG). General Curtin had organized CECOG on April 1, 1966 at Wright-Patterson AFB, Ohio, as a field extension of the Air Staff. General Curtin selected Wright-Patterson AFB for its proximity to the civil engineering school.[154] Col. (later Brig. Gen.) William T. Meredith commanded the new organization. CECOG was responsible for "the field organization, training, deployment, use, and logistical support of civil engineering forces to meet heavy repair and minor emergency construction requirements in support of the Air Force mission worldwide."[155] CECOG coordinated the assignment of Prime BEEF teams, assembled and activated RED HORSE squadrons, and oversaw the assignment of officers and enlisted personnel for both groups. In addition to managing and training personnel, CECOG ensured the availability of equipment and materials for jobs assigned to Prime BEEF teams and RED HORSE squadrons, particularly during deployments to Southeast Asia. This mission involved CECOG in contingency planning and logistics, as well as field testing of equipment.[156] General Meredith recalled the formation of CECOG,

> Right after the work we did to establish Prime BEEF was when the Pentagon recognized that we needed something like CECOG. I think Curtin was behind it, because he was traveling in the Pacific at that time, and he sent a message back. He said, "Get this done. Meredith, you move out there [to Wright-Patterson AFB]. Get whoever you need." I knew where [Col. Truman] O'Keefe was then.[157]

Colonel O'Keefe served as the deputy of the organization and directed a staff of 50. General Meredith credited General Curtin with the name. "We asked, 'What are we going to call it?' He said CECOG, 'Civil Engineering Construction Operations Group.'"[158] As summarized by General Meredith, "CECOG's total spectrum was combat support, whatever combat support was. It was total control of the combat support forces and the necessary logistics and training to support them."[159]

The 1968 reorganization study by the Directorate of Civil Engineering identified overlapping responsibilities between CECOG and other Air Staff divisions. General Goddard, therefore, made the decision to consolidate several functions in an expanded organization. General Goddard characterized the new organization as field oriented and involved with people and equipment. The organization had the responsibility to match "personnel skills, training, posture and grade distribution with the type, functionability, maintainability, and durability on the equipment side."[160]

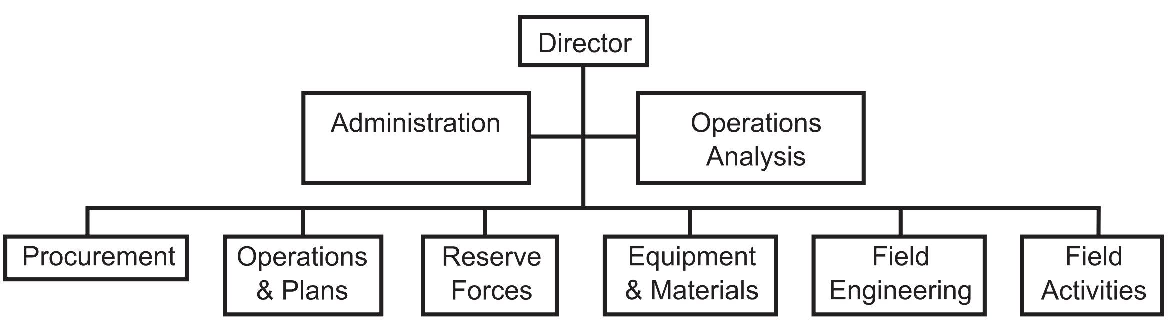
Civil Engineering Construction Operations Group Emblem

On May 15, 1968, CECOG was renamed as the CEC. Its organizational structure was approved on July 19, 1968. The new organization was authorized with a staff of 73 comprising 28 officers, 16 civilians, and 29 Airmen, who served in three branches: Operations and Plans, Field Engineering, and Equipment and Materials. CEC's first commander was Col. Robert G. Gardner. The CEC assumed responsibility for managing and monitoring the Prime BEEF and RED HORSE programs and training personnel. Other responsibilities assigned to the new center included: contingency planning guidance and assistance; career development; special studies and programs for noise abatement, bird control, conservation, sonic booms, bomb damage repair, and vulnerability, including the shelter program; guidance on specifications and validation of programming criteria for construction materials; technical support for research and development and applied engineering; technical writing services; liaison with manufacturers, other services, and major commands regarding tests of equipment; and, the forestry program.[161]

In 1968, CEC initiated several specialty and training changes in the Airman career fields. Revisions to exterior electrical work, heating, pavements, site development, real estate and cost analysis, maintenance and control were approved and scheduled for publishing.[162] In addition, the Field Engineering Branch was charged with creating and maintaining a program for site selection for air bases using in-house expertise suitable for deployment anywhere in the world. The center also maintained a roster of military personnel with technical expertise for special projects.[163]

By 1970, the CEC was reorganized into eight branches: Procurement, Administration, Reserve Forces, Operations Analysis, Operations and Plans, Equipment and Materials, Field Engineering, and Field Activities (Figure 3.6). The center served as the Air Staff's arm to establish policy ensuring

Figure 3.6 Civil Engineering Center Organizational Chart, 1970



Source: Col. Robert G. Gardner, "The Civil Engineering Center: Two Years Old, Mobility Is Our Mission," Air Force Civil Engineer, Vol 11, No 3, Aug 1970, 31.

that civil engineering personnel possessed the capabilities for contingency and emergency situations while supporting Air Force installations, both CONUS and overseas.[164] Colonel Gardner described the center as "a bridge between the Air Staff and major commands. Because of this, total civil engineering resources can be used to resolve common planning, personnel, operational, equipment, and engineering problems."[165]

The Center's organizational accomplishments after two years were noteworthy, particularly in the areas of contingency planning, base assistance, and the testing and evaluation of equipment. The center became a focal point for contingency planning. CEC was focused heavily in concept development and testing of mobility equipment, specifically under the Harvest Bare and Bare Base Program. In September 1971, CEC initiated the first World-wide U.S. Air Force Civil Engineering Contingency Planners' Conference at Wright-Patterson AFB, Ohio. Eighty participants attended representing the Joint Chiefs of Staff, the Air Staff, unified commands, and all major commands. The main objective of the conference was to assure that the direct combat support mission of Air Force civil engineering was supported through appropriate contingency planning documents governing service missions. One day of the conference was dedicated to discussions divided among six panels: civil engineering force posture/training/sourcing, civil engineering intelligence requirements, joint base development planning, use of modular relocatable structures, criteria for accomplishing civil engineering joint base development plans, and disaster preparedness and base recovery planning. Thirty-four recommendations were developed as a result of the conference.[166]

In 1971, CEC was assigned the operational responsibility to review all base development plans (BDP) for unified commands.[167] A BDP was defined as "a detailed document outlining facility requirements, existing assets, deficiencies and construction forces required to overcome the deficiencies in a time frame acceptable to support the contemplated military operation on a given airfield."[168] Preparation of BDPs required data on site selection in the theater of operation, on the theater weapon system, on the requirements to support the weapons system, and on personnel requirements for deployment in appropriate sequences within prescribed time frames. In addition, planners factored in the potential, as in the case of the Vietnam conflict, for short-term contingency operations supported by airlifted prefabricated units, which might evolve into a long-term sustained deployment requiring durable pre-engineered structures. Baseline data were analyzed and translated into the standard base planning factors, (manpower and equipment force packaging system, unit type codes, DoD category codes) using a time-phase deployment approach recently adopted by the Air Staff. In 1971, all standard base planning factors were individually calculated; the CEC was charged with identifying a mechanized system to support the process. In 1972, the Tactical Air Command deployment scheduling package was adopted Air Force-wide.[169] In 1971, the Pacific Command was the first command to include the use of RED HORSE squadrons to erect expedient facilities in its BDP.[170]

CEC offered several additional services to Air Force bases. By 1970, the center assembled 14,000 resumes of Air Force military and civilian technical experts who were available for consultation on a wide range of Air Force problems.[171] Airfield pavement was a particular area in which bases required expertise and support. By the early 1970s, aircraft weighing nearly 800,000 pounds were landing on pre-1955 airfields designed to accommodate aircraft weighing less than 400,000 pounds. The Air Force operated from over 500 million square yards of pavement, including runways, taxiways, and parking aprons. The replacement cost for airfield pavement alone was estimated at $7.5 billion. Maintaining these runways in serviceable condition was critical to the Air Force's flying mission.[172]

In 1970, CEC established an in-house pavement evaluation team and initiated a program to survey all operational air bases to evaluate pavement and to assist with pavement issues, as well as to generate data for studies to evaluate pavement roughness.[173] By 1972, the pavement evaluation team conducted 38 studies. By late summer 1971, the expert team was equipped with portable field testing equipment for both destructive and non-destructive techniques for evaluating airfield pavements and access to a full laboratory for analyses. The demand for the pavement team's expertise grew so great that CEC prioritized evaluations to greatest-need partial pavement evaluations with programmed maintenance and repair funding or cases where radical mission changes were anticipated.[174]

Fire protection/aircraft rescue was another area in which the CEC developed expertise to support the bases. In a March 1971 letter to the major commands, Lt. Gen. George Boylan, Jr., DCS/Programs and Resources, called for action regarding aircraft fire protection. This letter read in part:

> The deficiencies which continue to surface during the Air Force Inspector General (IG) no-notice inspections of the base aircraft fire protection and crash-rescue activity are a matter of concern to the Chief of Staff…To assist the major commands in self-evaluation and objective analysis, and to give direction to the total Air Force aircraft fire protection and crash rescue program, a new capability is being established at this headquarters under the Civil Engineering Center (AF/PREC) at Wright-Patterson AFB, Ohio.[175]

On March 29, 1971, the first of three Aircraft Rescue Field Assistance and Evaluation Teams (ACRFAET) was formed. The first team reported for a four-week training course at the Fire Protection School at Chanute AFB, Illinois. The first evaluation and assistance visit was conducted from May 25 to June 3, 1971 at Travis AFB, California. A thorough evaluation of the entire fire protection functional area was conducted, and assistance was provided in areas found deficient. The second ACRFAET team reported to Chanute AFB for training on June 21, 1971. The second and third ACRFAET teams became operational during the first quarter of FY72. In September 1971, CEC assumed functional responsibility for fire protection, which was previously assigned to the Fire Protection Group at the Air Staff. The latter group was inactivated September 30, 1971.[176]

The three ACRFAET teams provided assistance to major commands and to base firefighting organization in self-evaluation and objective analysis, as well as provided direction to the overall Air Force aircraft fire protection and crash rescue program. The four-member ACRFAET teams were composed of two civil engineering officers and two NCOs who were experienced firefighters. By December 1972, ACRFAET teams had made 24 unannounced visits to bases with high-value mission aircraft. The teams normally visited each base for a week. Four exercises and drills, two crash rescue exercises utilizing a mission aircraft, a hot fire drill at the fire training area, and one structural drill on a complex facility were held during each visit. The teams also provided in-depth analysis of the base's fire prevention program, firefighting vehicle maintenance and operations, and the fire department training, operations, and management activities. On March 8, 1972, the additional task of evaluating aircraft arresting systems was assigned to the ACRFAET teams. The teams were praised for their success in advancing the performance of base firefighting departments, improving communications between Air Staff and bases, and solving long-standing issues.[177]

In July 1971, a six-member Corrosion Analysis Team was established at CEC to conduct field corrosion surveys of facility and utility systems to quantify corrosion problems at the bases. Team members received formal training in cathodic protection analysis, water treatment, and gamma radiography. After training, the team conducted field tests of cathodic protection systems, water analysis systems, and non-destructive inspection of pipe systems. By 1972, the Corrosion Analysis Team had conducted approximately 12 visits. Training for base-level corrosion engineers and technicians was one area addressed by the team. In 1973, CEC held a series of regional workshops to provide instruction on current technology, theory, and field testing procedures in corrosion analysis to base personnel.[178]

CEC also provided assistance in base recovery planning, an area involving all civil engineers at bases throughout the Air Force, particularly in recovery efforts following natural disasters. Air Force Manual 93-2 entitled *Disaster Preparedness and Base Recovery* was published in June 1970. By 1971, CEC fielded recovery capability evaluation teams to assist bases in developing disaster recovery plans that provided practical and realistic guidance in a single, unified document. Earlier base recovery plans often lacked detail on utility operations functions, did not address emergency equipment and

Building 548, Air Force Civil Engineering Center's first home at Tyndall AFB, Florida.

materials, and did not fill key recovery team positions with Prime BEEF recovery team personnel. Prime BEEF-Recovery (R) teams had to meet specific staffing requirements, and personnel also had to be trained to implement recovery plans effectively.[179]

In the area of test and evaluation, CEC personnel were involved actively in evaluating equipment for potential purchase. CEC personnel conducted tests on snow removal equipment, and assisted in developing and acquiring the new P-4 crash truck for firefighters. Since January 1969, the center maintained an inventory of surplus equipment, including generators, for distribution among Air Force bases. The CEC also worked in the area of bomb damage repair and contracted for tests on a backfill system designed for one hour crater repair. Center personnel managed a contract to increase the number of modular facilities available to the Air Force.[180]

The decision to move CEC to Tyndall AFB in Florida was announced on December 10, 1971; relocation was scheduled for the summer of 1972. At the time of the announcement, then Col. William D. Gilbert served as Director of CEC and the center had an authorized staff of 206 personnel. The center had outgrown the facilities at Wright-Patterson AFB. Additional office space, expanded laboratory space, and greater land to accommodate Prime BEEF and RED HORSE training were required. Relocation to Tyndall made physical expansion possible. In addition, assigning additional military missions to Tyndall AFB was supported by the area's Congressional Representatives. Colonel Gilbert traveled to Tyndall AFB to inspect available space and selected the new, but unoccupied, flight training building (Building 548) over the objections of the base commander.[181]

As plans for the move advanced the Air Staff renamed the CEC as the Air Force Civil Engineering Center (AFCEC) and transferred the organization to the Air Force Systems Command (AFSC). This transfer was a result of a study on the Air Staff organization that recommended dismantling field extensions. The CEC had an established and effective evaluation and testing capability, which was more aligned with AFSC than with the Directorate of Civil Engineering.[182] Transfer to AFSC enhanced AFCEC's role in research, development, testing and evaluation of new equipment and technologies for products to support Air Force civil engineering requirements world-wide. All responsibility for Air Force policy along with 20 personnel slots reverted to the Air Staff as part of the transfer. Col. (later

Brig. Gen.) Paul Hartung organized the physical move to Tyndall AFB, which occurred in phases between June and August 1972. Colonel Hartung served as the organization's commander until June 1973. The AFCEC commander reported directly to the AFSC commander to accomplish the mission.[183]

AFSC had a long record of research into civil engineering topics through the AFWL at Kirtland AFB, New Mexico. In 1950, the Special Studies Office of the Design Branch, Installations Engineering Division under the Air Materiel Command at Wright-Patterson AFB, Ohio, was established to undertake research into civil engineering topics. This office supported research in damage assessments from nuclear weapons and in design criteria for structures to withstand nuclear attack. In 1956, the office was transferred to the Air Force Special Weapons Center at Kirtland AFB, and became the Structures Branch in the Research Division. Throughout the 1950s, civil engineering research and development was focused on the physical damage posed by nuclear weapons and the development of protective structure design.[184]

In late 1963 and early 1964, the Air Staff authorized a study to identify the best structure for the Air Force civil engineering research program. AFWL was directed to complete the study and prepared a detailed plan for managing, implementing, and executing civil engineering research and development. This plan was approved in May 1964. The drivers for civil engineering research during the early 1960s were future construction and equipment demands for space and missile facilities. The Structures Branch in AFWL was renamed the Civil Engineering Branch and transferred to the Development Division in 1965. In December 1965, AFWL was charged with the responsibility to plan, manage, and conduct all civil engineering research programs. The number of personnel in the Civil Engineering Branch increased to 56 by May 1966 and the branch operated with a budget of over $2 million in FY66. In December 1966, AFWL was designated as the lead laboratory and central manager for civil engineering research and development. The Civil Engineering Branch was organized with the following offices: Protective Construction, Facilities Technology, Experimental, and Special Projects. Protective Construction continued the work on nuclear weapons effects. Facilities Technology undertook research in the areas of structures, soils and pavements, and environics. The Experimental office supported the research programs of the other two offices and worked to improve field testing procedures through state of the art techniques. Special projects provided administrative support and operated the Civil Engineering Technical Information Service. Research also was conducted at the Eric W. Wang Civil Engineering Research Center operated by contract at the University of New Mexico.[185] Research during 1966 included field tests associated with the Minuteman missile sites, protective revetments and other structures to survive conventional weapons, testing of locally manufactured building blocks to support construction in remote areas using local materials, the use of drywall construction, and the spring mounting system for the Cheyenne Mountain complex.[186]

Research proposed by AFWL in 1967 was informed by experience in South Vietnam and included "wind load analysis of prefabricated buildings, sonic boom effects, non-nuclear aircraft shelters, bomb damage repair of airfield pavements, aircraft landing mats, unimproved landing areas, and aircraft revetments."[187] By May 1968, 76 personnel were assigned to the Civil Engineering Branch, including 50 professionals. Research and development activities were augmented by 85 contractors employed at the Eric C. Wang Civil Engineering Research Civil Engineering Research Center. In 1970, the branch was renamed the Civil Engineering Division. Total funding for civil engineering research reached nearly $5.1 million in FY70; nearly $1.7 million was allotted to research in seven areas: nonnuclear protective systems, site selection and planning, environmental engineering, airfield surfacing and foundations, mission support systems, structural systems and materials, and base support systems.[188]

AFCEC was transferred officially to AFSC on June 29, 1972. It was organized into the following directorates: Equipment Systems, Procurement, Operations, Field Technology, Laboratories, and Engineering. Staffing was authorized at 186, comprising 46 officers, 124 enlisted, and 16 civilians. AFCEC occupied five facilities totaling 46,000 square feet. Of the total space, 10,000 square feet were dedicated to laboratories for soils, asphalt and concrete, wet chemistry for water analysis, and radiography.[189]

Air Force Civil Engineering Center's Environics Laboratory at Tyndall AFB, Florida.

AFCEC continued to assist bases in the areas of corrosion control and prevention surveys, airfield pavement evaluations, aircraft crash rescue and fire protection, site selection surveys, equipment evaluations, snow and ice removal, and inventory control of contingency materials, such as revetments and modular relocatable facilities. AFCEC also, upon request, monitored and assisted Prime BEEF and RED HORSE teams with organizing, training, manning, and equipping needs. Research and development at the new center was focused on air base vulnerability/survivability, air mobility, environmental engineering, and air base support.[190]

Among the tasks accomplished during AFCEC's first year was formulating the research and development program for inclusion in the FY74 budget cycle. Research conducted during the period was related to bomb damage repair procedures for incorporation into a revised AFM 93-2, *Disaster Preparedness and Base Recovery Planning*. Equipment evaluations were conducted for a concrete batch plant and a laser system to control grading equipment. AFCEC also developed a machine to reshape steel arch panels used to construct hardened aircraft shelters in Europe to house F-111 aircraft. AFCEC personnel evaluated the properties and effectiveness of three commercial ice-control chemicals for Air Force use.[191] The FY74 research and development budget request for $1.1 million was not fully funded. Tasks established for research included air base survivability/vulnerability, air mobility, environmental engineering, and air base support.[192]

Bomb damage repair and rapid runway repair were two areas of early research. Bomb damage repair and rapid runway repair took too much time, required extensive equipment, a large number of personnel, and often resulted in an impermanent repair.[193] Based on the successful results in South Vietnam, pierced steel planking (PSP) was investigated for initial repairs followed by an evaluation of AM-2 matting.[194] AM-2 matting proved the best option for emergency repairs after alternative materials testing by AFWL. Research also was focused on assessing the roughness of pavement surfaces to eliminate structural damage to aircraft, as well as research into alternate launch surfaces using unconventional materials such as sod. Other initiatives undertaken by the AFCEC included the investigation of camouflaging bases and the runways using smoke screens and vegetation.[195]

In March 1975, civil engineering research and development activities conducted by the Aerospace Facilities and Environics Branches of the AFWL were reassigned to AFCEC to consolidate responsibility and coordination under a single manager. Relocation of personnel and equipment was authorized in September 1975. The AFCEC organization was expanded to seven directorates through the addition of the Directorate of Programs.[196] By December 1975, the mission of AFCEC was twofold. The organization:

1. Provided HQ Air Force, Directorate of Civil Engineering, and other Air Force civil engineering units and activities, including Reserve forces, with specialized technical services and planning assistance in the civil engineering and environ mental planning areas that require specialized equipment or knowledge beyond that normally possessed or economically/technically feasible to maintain in the major commands…;
2. Functioned as lead center for research and development related to Air Force civil engineering, and environmental quality, including exploratory, advanced, and engineering development, as well as lead testing agency for civil engineer ing related systems, techniques, materials, and equipment.[197]

Major research projects for 1975 included air base survivability studies for aircraft, personnel, runways, and fueling facilities; development of a research program to study pressing environmental problems in the Air Force; development and testing of air mobility shelters; corrosion and pavement studies; fire protection; special equipment improvements; and, studies related to energy conservation. AFCEC's role in providing assistance to major commands and bases expanded to include environmental planning assistance, such as support in mapping noise irritant levels around air bases to support the AICUZ program, and in the development of environmental impact statements required under NEPA.[198] On July 1, 1975, AFCEC established a Bird/Aircraft Strike Hazard (BASH) team. The team conducted ecological surveys of flora and fauna at Air Force bases. Surveys were prioritized based on the base history of bird-strikes. The team issued reports that recommended control measures and operational procedures to reduce bird-strike hazards. Survey data were computerized for future environmental and operations planning.[199]

Air National Guard and Air Force Reserve

Air Force Reserve Forces, including Air Force Reserve and ANG civil engineering personnel, became increasingly integrated into the manpower allocations that supported the Air Force mission. Civil engineers in the Air Reserve Forces numbered a few hundred in the early 1960s and increased to 2,800 by 1967. In 1960, Air Force Reserve civil engineers were redesignated as Civil Engineering Squadrons (CES). In the Air Force Reserve, these personnel were assigned across 15 Air Force Reserve Troop Carrier Wings. Civil engineers at ANG installations typically were installation based and served with their state units during training sessions. By 1966, ANG operated 91 flying and 49 non-flying bases.[200]

ANG civil engineers also served with the National Guard Bureau. The total ANG real property inventory in 1966 was valued at $350 million; the average military construction program budget was $20 million yearly and the average operations and maintenance budget was $2.5 million. The ANG MCP budget was developed from project estimates submitted by bases and states to the Air Civil Engineering Division at the National Guard Bureau. The Air Civil Engineering Division at the National Guard Bureau was staffed by 12 persons, including the division chief, deputy chief, three civil engineers, two construction management engineers, a real property specialist, an engineering technician, a draftsman, and two clerk/typists. This group reviewed proposals for more than 1,200 construction and repair projects per year.[201]

Civil engineers assigned to ANG flying bases typically accounted for the only full time military staff at the base. The base civil engineer was supported by a small number of full-time state employees who performed custodial duties. The staff level of the typical 85-man ANG CES rose to full strength during weekend training sessions. Twenty-nine of the CES staff were firefighters; the remaining 53 personnel of the ANG CES comprised 3 officers and 50 Airmen. The latter represented a wide variety of skill sets in the architectural and engineering fields. The typical ANG base maintained by the ANG civil engineer comprised a runway, headquarters building, dormitory, dining hall, civil engineer facility, base supply and equipment warehouse, hangar, aircraft operations support buildings, jet fuel storage, ammunition storage, fire station, and utilities.[202]

Beginning in 1964, civil engineer reservists were incorporated into the Prime BEEF mission and included in training exercises to measure skills. However, the wartime role of Reserve civil engineers was ill defined; it was recommended that their assignments be restricted to emergency response teams in times of natural disaster.[203] The first test of Reserve and ANG civil engineers occurred during the 1968 *U.S.S. Pueblo* Crisis. Reserve civil engineers were activated along with their units. The civil engineer elements attached to the ANG fighter units assigned to TAC were deployed in 20-to-30-person crews to stateside Air Force bases for a modified Prime BEEF training program. Reserve civil engineers whose units were deployed by MAC also participated in the training program, which comprised practical training projects in real situations and assisted the command with high priority construction work. Both TAC and MAC leaders recognized the skills of individual Reserve engineers. The Reserve and ANG engineers put in long working days, displayed aggressiveness to get the jobs done, and performed their tasks with skill. Displaying the "can-do" attitude of RED HORSE units, these units were dubbed the "Pink Pony" of the Air Force.[204] This training experience was credited with contributing cohesiveness in the overall Reserve engineering program.

Notwithstanding the successful performance of individual Reserve civil engineers, the 1968 exercise identified the need for greater direct management and training designed for team building. Maj. Gen. Guy H. Goddard made one of his priorities providing ANG and AFRES civil engineering units with appropriate training and equipment to supplement the Air Force mobility forces.[205] He approved the following proposals based on input from ANG and Reserve managers, MAC, and TAC:

- Each unit had to be organized as a separate flight attached directly to a flying unit instead of being an integral part of a support unit.
- Each unit had to be trained under a time-phased specialized training program to common standards established by the Air Force.
- During annual active duty training periods, units had to deploy either to active duty bases for project training or to specialized training sites for training under field conditions. [206]

In 1969, an advisory office for Reserve Forces was created at CEC, and Prime BEEF planning and management agencies were established at both the Air Force Reserve and the ANG headquarters.[207] In February 1970, CEC was assigned as the training coordination agency for the Air Force Reserve and ANG civil engineer units. The program was conceived with two objectives: to provide training in Air Force civil engineering operations and to identify meaningful projects for the units. The first project in the formal training program was undertaken between May and July 1970, when three ANG Prime BEEF teams traveled to Nellis AFB, Nevada, to dismantle and repackage 14 modular relocatable dormitories in use since 1968. Five relocatable dormitories were prepared for shipment to Castle AFB, California. The job was scheduled for completion over three successive two-week periods. The three teams completed work four days ahead of schedule.[208] Similar training programs were instituted for the Air Force Reserve civil engineers. In FY73, Air Force Reserve civil engineer Prime BEEF teams were deployed on projects in Alaska, Germany, Spain, Hawaii, and several AFBs in CONUS.[209]

Training for the Reserve Forces became more critical with the policy change making the Reserves an integral part of the Total Force. Under Total Force, Air Force Reserves and ANG units now were deployed directly to a contingency as opposed to replacing deployed Air Force civil engineers at stateside bases. By 1973, Air Force Reserve civil engineers were organized into 34 civil engineering flights and 60 Prime BEEF-C teams staffed by 85 personnel.[210] The ANG had 93 civil engineering flights. Unofficially known as Air National Guard of the United States, or ANGUS, Prime BEEF, these personnel were divided among flying teams (F), independent teams (C), firefighters (FF), and recovery teams (R).[211] By the end of the 1972 training season, the Air Force Reserves Prime BEEF teams completed a three-year training schedule and a combat simulation program. The training program resulted in well-trained, capable teams and improved facility support to home stations.[212]

In 1971, the ANG civil engineering program expanded through the formation of two RED HORSE units. The 200th Civil Engineer Squadron was stationed at Camp Perry ANG Station, Ohio, while the 201st Civil Engineer Flight was stationed at Fort Indiantown Gap, Pennsylvania.[213] By 1975, the approximately 12,000 Air Reserve Force civil engineers included 4,000 in the Air Force Reserves and 8,000 in the ANG.[214]

MANAGING THE PERMANENT AIR FORCE BASES

Introduction

The base civil engineer served as staff officer under the base commander and planned, supervised, directed and coordinated the maintenance and repair of real property; the operation of utility plants; design, construction and alteration of real property facilities; real estate actions; fire protection and rescue; pest control; traffic engineering; and, maintenance and repair of all government-owned or leased equipment. In addition, the installation recovery from damage or destruction by enemy attack or other disaster was assigned to the base civil engineer.[215] General Minton acknowledged that, while design and construction of new facilities held much more glamour,

> A greater challenge, and one of perhaps even more importance, is the maintenance and operation of our plants. Additions, modifications and major repairs are constantly required to keep them operational. The job of maintaining and operating an installation, however, does not start with its completion. The Engineer's responsibility begins when a project is conceived and continues through the design and construction phase. He should have low maintenance cost potential and operating efficiency as his goal. The base engineer's professional knowledge determines the best siting of the facility, insures [sic] technical review of plans and competent inspection of construction. Familiarity with all phases of the project permits more effect M&O [maintenance and operations].[216]

The base civil engineer's responsibilities comprised oversight of facilities that averaged 4,000 acres in size during the early 1960s. Typically, the base had 2 million square yards of hangar and shop space, and 500,000 square feet of administrative, warehousing, and community support buildings, all of which required utility services. The typical base supported 8,800 people who either worked on the base or lived in base-provided family housing. Utilities included electricity, water and sewage disposal. The typical base budget for operation and maintenance was nearly $2.5 million.[217]

By the early 1960s, number and value of Air Force real property had increased dramatically from the mid-1950s. In 1955, Air Force real property assets were valued at $6 billion; by 1960, old and new facilities were valued at $14 billion. These dollar figures illustrate the increased number of buildings, structures, and infrastructure maintained and repaired by the base civil engineering organization.[218] Family housing completed under the Wherry and Capehart programs represented a large addition to the Air Force inventory. Technologically complex facilities, such as dispersed missile installations and radar listening posts, also were added and required specialized technical skills to maintain and to repair. Operations and maintenance budgets, though increased over late 1950s levels, did not rise sufficiently to fully maintain the increased number of facilities.[219]

The base civil engineer typically led an extensive organization of personnel who oversaw the administration, operation and maintenance of fixed base assets, as well as planned for base improvements, alterations and upgrades to existing facilities. The shops were vital to maintenance activities. Maintenance crews available 24/7 provided for all types of maintenance and repairs to maintain mission requirements. The typical base civil engineering force numbered approximately 300. On a large base, the civil engineering staff could number 900 persons, including both military and civilians.[220]

Managing this expanding organization effectively, efficiently, and within reasonable costs was a continual challenge. As General Minton wrote, "Our responsibilities in the M&O (Maintenance and Operations) area are increasing tremendously. Manpower resources and dollars are not increasing proportionally. To accomplish the civil engineering mission this gap must be filled with quality of management rather than quantity of resources."[221] Efforts were made on the base level to streamline the civil engineering organization through the introduction of the work control center, adoption of automated data processing, and experimentation with organizational and personnel management techniques used in private industry. In addition, base civil engineers complied with a growing number of environmental laws related to base operations and land use planning. A number of Air Force initiatives were issued to control energy costs.

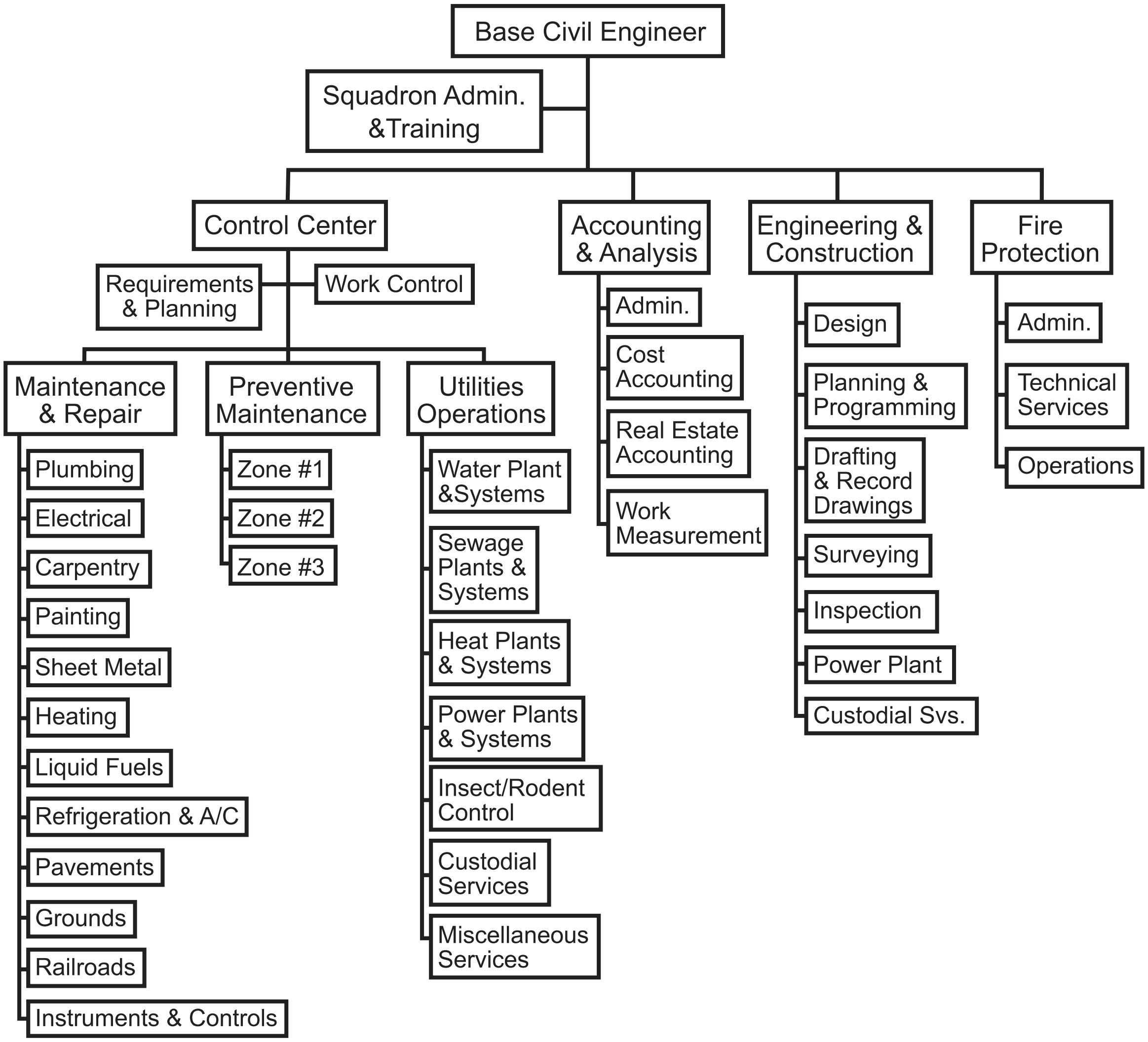
The consequences of the 1972 transition to an all-volunteer force were felt by the Air Force in the mid-1970s. Declining personnel numbers related to the elimination of the military draft prompted plans to contract out nontechnical tasks previously performed by Airmen, especially custodial services. The FY72 operations budget included $3.1 million to outsource such services. It was estimated that the total cost of contracting custodial services would reach $52.5 million per year.[222]

Reorganization of the Base Civil Engineer Organization and the Work Control Center

During the early 1960s, a major change was instituted in the base level civil engineering structure to streamline productivity and increase the efficiency of maintenance and repair activities to control mounting workloads. Credit for the concept was given to Col. (later Brig. Gen.) Henry "Fritz" J. Stehling.[223] In July 1961, the base civil engineer control center was formally established through revisions to AFM 85-1, *Maintenance Management for Real Property Facilities*. The purpose of the control center was to increase "efficiency in the direction and control of materiel support, procurement, transportation and plant modernization." Maj. Gen. Augustus M. Minton noted, "This is a real advance, with far reaching possibilities for increasing the effectiveness of our base maintenance work forces."[224] The work control center grew out of SAC procedures implemented in 1958, which provided base civil engineers with a central structure for directing and managing their work force.[225]

Air Force Regulation 23-33, *Base Civil Engineer Organization and Functions*, dated December 1961, defined the realignment of the base civil engineer organizational structure to accommodate the work control center (Figure 3.7). The base civil engineer oversaw the control center, as well as the directorates of accounting and analysis, engineering and construction, and fire protection. The Accounting and Analysis office, renamed Industrial Engineering in 1964, performed the administrative work for the base civil engineer organization, provided statistics and cost information to support base maintenance and operations, assembled and analyzed cost data, studied performance data, and maintained the current real property inventory. Engineering and Construction prepared technical project data, engineering studies, and evaluations of facilities and systems; monitored development of military construction programs on the base level; prepared engineering drawings, surveys, and maps; performed technical inspections of all construction work; coordinated engineering activities with higher command and construction agencies; reviewed bids for contracts construction and repair; and, negotiated utilities rates contracts. Fire Protection operated the fire and aircraft crash rescue services, as well as performed fire inspections, developed base fire regulations, and investigated fire incidents.[226]

Figure 3.7 Base Civil Engineer Organizational Chart, 1961



Source: AFR 23-33, "Base Civil Engineer Organization," 1961, 3.

The control center was established as a centralized office to apply the "techniques of planning, scheduling, and work measurement" to all jobs undertaken by Air Force civil engineers on the base. Planning, estimating, scheduling, and tracking of work and service orders occurred in the control center. The director of the control center reported directly to the base civil engineer. The control center comprised two offices: Requirements and Planning, and Work Control. Elements under Requirements and Planning were Inspection, Planning, and Material Control. This office planned and estimated proposed work, made on-site investigations to plan the proposed work; planned labor and materials for each job order; forecast personnel scheduling; and, inspected facilities for maintenance and repair needs, controlled inventories and procured job supplies. The Work Control office operated the control room, processed work requests into work orders, prioritized and scheduled jobs based on materials and manpower availability, operated the service call system, and controlled scheduling of vehicles.[227]

Three branches reported to the director of the control center: Maintenance and Repair, Preventive Maintenance, and Utilities Operation. Maintenance and Repair oversaw the shops, which were organized by construction specialty. Shops included plumbing, electrical, carpentry, painting, sheet metal, heating, liquid fuels, refrigeration and air conditioning, pavements, grounds, railroads, and instruments and controls. The Preventive Maintenance branch oversaw the preventive maintenance program. This program was executed by maintenance crews working from mobile trailers within established work zones on a base. The Utilities Operation branch oversaw the following areas: water plant and systems, sewage plant and systems, heat plants and systems, power plant and systems, insect and rodent control, custodial services, and miscellaneous services, such as solid waste disposal.[228]

The hub of the work center was the work control room, the physical nerve center staffed by personnel who received all service calls and work requests, translated the work requests into job orders, prioritized and scheduled the work, and communicated and coordinated the requests with the appropriate shops. In the control room, the status of each work or service order was posted on display boards and charts around the room for all to see. Display boards showed the installation map, the work load charts, status boards for all projects, and the status of the vehicles. The display boards were updated continually.[229] A model control room was created at Andrews AFB, Maryland, to demonstrate actual working concepts and conditions for the Air Staff and major commands.[230]

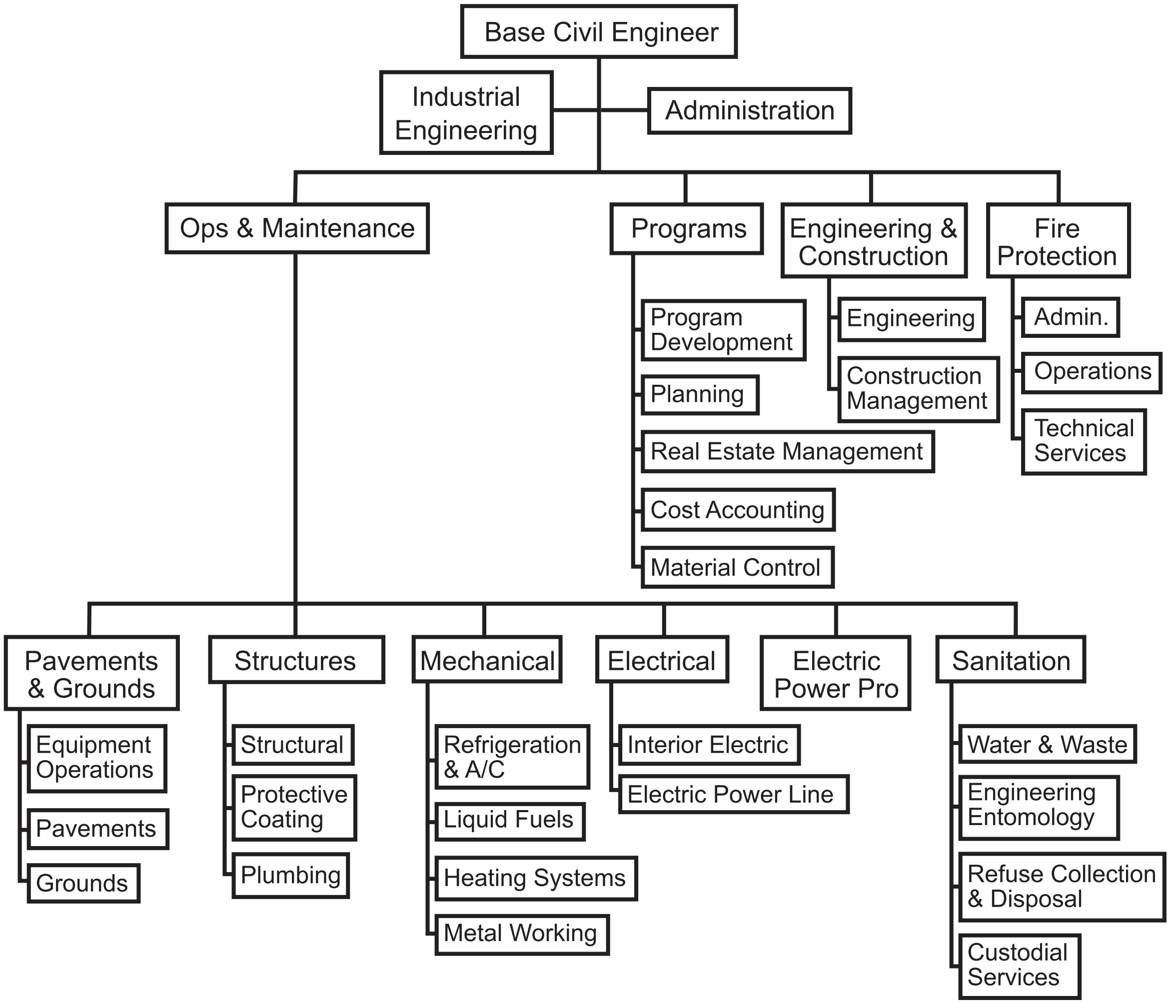
As implementation of AFR 23-33 and AFM 85-1 progressed, the need for an aggressive training and immersion program became apparent. A Model Base Program was established. In 1964, two one-week training sessions on the central work control center were conducted at Wright-Patterson AFB, Ohio. Base civil engineers from seven bases received instruction in the effective operation of central control centers for civil engineering activities, as well as training in maintenance management concepts and procedures. The bases represented were Hamilton AFB, California; Sheppard AFB, Texas; Ellsworth AFB, South Dakota; Seymour Johnson AFB, North Carolina; Andrews AFB, Maryland; Bunker Hill (name changed to Grissom in 1968) AFB, Indiana; and, Wright-Patterson AFB, Ohio. Once trained, the civil engineers returned to their bases to institute upgraded civil engineering systems and procedures and these bases became model bases to illustrate the new management concept. These bases tested new systems and procedures prior to Air Force-wide implementation. Once certified, the model bases provided examples for other nearby bases.[231] The Model Base Program and the implementation of the work control center led to the formal revision of AFM 85-1, *Maintenance Management for Real Property Facilities*, published in July 1967.[232]

Implementation of the work control center improved base-level maintenance operations, enhanced preventive maintenance operations, and introduced efficiencies in procedures and management. Centralized control made possible improved scheduling and work flow for shop personnel. Centralized control also assured the availability and efficient use of materials. Economies were achieved as fewer work orders were interrupted or delayed due to insufficient materials. Scheduling of vehicles to transport work crews to job sites was improved through centralized control.[233]

During 1965 and 1966, attention was turned to revising AFR 23-33. Major command civil engineers were requested to submit suggestions for changes to the regulation. Recommended changes then were circulated among leadership. Six bases from four major commands were selected to field test the proposed organizational changes prior to finalizing the regulation. The proposed organizational changes introduced several new offices and reorganization of the shops. The base civil engineer oversaw administration, industrial engineering, operations and maintenance, programs, engineering and construction, and fire protection. The work control center and the shops for pavements and grounds, structures, mechanical, electrical, electric power production, and sanitation were organized under operations and maintenance (Figure 3.8). The duties of the work control center were refocused on scheduling, executing, and tracking the maintenance and repair work. Preventive maintenance functions were no longer a stand-alone branch, but folded into the overall activities of the operations and maintenance function.[234]

Improvements to the work control center and personnel scheduling function continued to be implemented. Brig. Gen. Archie S. Mayes, Deputy Chief of Staff for Civil Engineering at SAC, supported testing new procedures on SAC bases. The first procedure investigated was a graphic In-Service Work Plan. Work control center display boards were modified to include the current month's workload and work projected for the next six months. The expanded display boards visibly summarized

Figure 3.8 Base Civil Engineer Organizational Chart, 1966



Source: John Ward, "AFR 23-33 Revision Test," Air Force Civil Engineer, Vol 7, No 4, Nov 1966, 8.

work requirements and manpower availability. The new display boards further supported the planning process by detailing the tasks required for new work to proceed. The new system also involved superintendents and work center foremen in daily planning. In 1971, the visual In-Service Work Plan was tested at 17 SAC bases.[235]

A second innovation designed for efficient work force management was tested at 16 SAC bases. Accounting for the daily activities of shop personnel was transferred from the shop foremen to the work control center. Work control center superintendents and comptrollers now scheduled the daily assignments of shop personnel. The foremen were responsible for moving personnel to work assignments as rapidly as possible. Personnel contacted the work control center when work was completed at a job site; transportation was dispatched through the center to move crews to the next job. At the end of the day, work control center comptrollers responsible for tracking job-site personnel submitted man-hour spread sheets to cost accounting. The revised procedure relieved shop foremen of time-consuming paperwork and allowed them to supervise work in the field. Positive results realized from this change were centralized personnel control, increase of individual productivity, reduction of lag time, reduction of shop administration and overhead, and increases in scheduling.[236]

In May 1970, under General Mayes, SAC bases updated and reintroduced an older concept. During the 1950s and early 1960s, bases typically maintained a manned "do it now" truck to undertake

Brig. Gen. Archie S. Mayes

small-scale preventive maintenance jobs, thus avoiding more costly damage. SAC instituted Structural Maintenance and Repair Teams (SMART). SMART was designed to complete small-scale service calls in high-use facilities, such as dormitories, and work places; family housing was excluded. SMART crews comprised carpenters, a painter, an electrician, and a plumber, as required. SMART crews were dispatched through a separate work center, had access to tools, worked out of a trailer while on the job site, and were supplied through a separate bench stock. After a visit to one SAC base, the Headquarters U.S. Air Force Management Review Team reported "The [SMART] team is accomplishing a great deal of minor maintenance and significantly enhances the image of the Base Civil Engineer."[237] General Mayes was credited with implementing many performance enhancing concepts to managing the base-level civil engineering organization through his service in three major commands. To honor him, Air Staff established the Brig. Gen. Archie S. Mayes award that recognized the most outstanding Programs Flight.[238]

Supplies

Assuring supplies for maintenance and repair jobs was often a challenge. In 1965, the Air Force made a concerted effort to standardize supply procedures at the air base level. The Air Force Standard Base Supply System was a computerized system that ensured identical procedures on all air bases. The Directorate of Civil Engineering participated in the development of the system and used it to improve procedures for maintenance and repair operations.[239] Once initial supply orders were entered into the system, all accounting and reporting information was automatically generated. Daily and monthly reports were produced to provide civil engineering with supply management data.[240]

By the mid-1960s, the cost of the conflict in Vietnam resulted in decreased funding for certain maintenance and operations budget line items. These line items included supplies. Available funding to procure supplies for preventive maintenance, and maintenance and repair activities on the stateside bases decreased 30 percent between FY65 and FY68.[241]

In November 1970, SAC began testing a new supply support system known as the Contractor Operated Civil Engineering Supply Store (COCESS). The purpose of this system was to facilitate timely procurement of supplies for maintenance support. Under this program, the Air Force installation contracted annually with local suppliers for direct procurement and by-passed the Air Force supply system. COCESS was field tested at Castle AFB, California, in 1970-1971. The potential advantages of COCESS included timely supply support, support of the commercial supply distribution system, lower on-base inventories, elimination of stock fund problems, and reduction in paperwork.[242]

By mid-1971, COCESS was operating at four bases. By the end of that year, SAC had 28 COCESS stores in operation. The Air Staff conducted a review of COCESS and recommended expansion of the program. By mid-1972, SAC received permission to implement COCESS on a permanent basis, pending a decision by the Office of the Secretary of Defense. Three major commands, MAC, TAC, and AFSC, were authorized to implement the concept command-wide gradually. Five other commands were authorized to operate COCESS at a single lead base.[243]

Fire Protection

Fire protection and prevention at Air Force installations world-wide were major concerns for the base civil engineer. The grave significance of fire prevention was illustrated by the number of lives lost and Air Force real property damaged or destroyed. As an example, in FY63, Air Force fire departments responded to 2,014 calls, 331 of which involved aircraft fires. Fifty-nine persons were rescued, while 152 persons died. The loss to real property and materiel was valued at over $162 million.[244] Maj. Gen. Augustus M. Minton acknowledged the importance of fire prevention when he wrote,

> It is the Air Force Civil Engineer's prime duty to educate the other members of the Air Force as to the chemistry of fire and to instill in them the idea that fire prevention is akin to cleanliness and godliness in the survival of mankind. Let it be said that **fire prevention is the human thing to do**![245]

New aircraft and weapons demanded that firefighters understood the complexity and inherent danger of the technologies involved. Therefore, training became a priority during the early 1960s. Fire Emergency Services consistently tested new equipment and techniques for better control and skill.

P-2 Fire Truck

During the 1960s, firefighters used a protein foam to extinguish fires. According to Chief Master Sergeant (Retired) Hugh Pike, a career military firefighter who continued his career as a civil servant at AFCESA, "It was marginally effective, for starters. It was made out of animal by-products, primarily animal blood…Well, it smelled pretty awful, but that's what we used. It was one helluva good fertilizer. It stunk to high heaven."[246] With the introduction of the C-5 aircraft, new fire protection techniques and products were needed to provide adequate safety measures. The Aqueous Film-Forming Foam (AFFF) was developed to flow quickly and to encompass fires completely. CMSgt Pike field tested AFFF during his time at Andrews AFB, Maryland, in the 1960s. The AFFF replaced the protein foam, which had been the standard for twenty years.[247] Other improvements occurred in the types of extinguishers used. In 1966, the Air Force removed all 50-pound carbon dioxide fire extinguishers from Dover AFB and installed new FEU-1/M Chlorobromomethane extinguishers.[248]

The Air Force also secured upgraded equipment for firefighters at AFBs throughout the world. The P-2 aircraft fire rescue vehicle was an 8 x 8, all-wheel drive truck with the carrying capacity of 2,500 gallons of water and foam. The truck's dispersal system discharged 24,000 gallons of foam solution per minute through roof turrets and a hand line. The size of the new truck allowed the Air Force to eliminate smaller and obsolete firefighting vehicles. The new trucks increased each individual firefighter's capacity, while requiring fewer personnel to operate the vehicle. The P-2 fire trucks and the F-7 water tanker were stationed at air bases in South Vietnam and two P-2s effectively suppressed a fire in a large bulk fuel storage area there.[249] Fire trucks procured during FY63 included 67 P-2s and 449 P-6s.[250]

AFWL, through AFCEC, continued to test and to improve firefighter equipment. The early 1970s saw the addition of several new vehicles to the fire services inventory, including the fourth-generation fire truck, the P-15 Crash Truck. The P-15 was equipped with 6,500-gallons of extinguishing agent.[251]

Firefighting training was continuously upgraded to meet industry standards. During 1972, the training manuals of the International Fire Service Training Association at Oklahoma State University were adopted as the U.S. Air Force Fire Protection Standard for Operational Structural Fire Suppression and Training.[252]

The Firefighter Badge

In June 1970, distinctive badges were authorized for fire protection personnel. The circular badge insignia read "Fire Protection USAF" topped by an eagle with outspread wings. The center of the badge contained an emblem that denoted levels of duty. The fire chief's badge was marked by five, gold crossed bugles. The deputy chief's badge had four bugles, and the assistant fire chief, three. The fireman's badge had a helmet, axe, and one bugle in silver.[253]

Cost Reductions

Cost control was a continual refrain throughout the period. In 1964, President Johnson informed the U.S. Congress that he was determined to reduce the cost of the Federal government. The DoD had instituted a cost reduction program in fall 1962. Initially, the cost reduction program was limited to realizing savings through improved management in procurement and logistics, but soon was expanded to all functional areas, including Air Force civil engineering. The DoD program established formal monetary goals, required reporting, and audited validation of cost savings. The DoD committed to reduce costs by $4 billion between FY63 and the end of FY65. By FY64, the Air Force's savings reached $1.9 billion. Some of the savings came from curtailing procurement costs, increasing use of excess inventory, buying at the lowest sound price, reducing operating costs, and increasing efficiencies of operations.[254] Additional savings were realized through reducing military family housing and real property management expenses.[255]

Cost control efforts were expected from each base in each major command. By 1966, major cost reductions were made in the following areas:

- utilities contract management,
- utilities conservation programs,
- adoption of the P-2 firefighting truck that reduced manpower needs,
- adoption of the base civil engineer control center that improved personnel resources,
- adoption of "do it now" vehicles for quick maintenance repairs,
- revised preventive maintenance procedures,
- disposal of excess and obsolete buildings that reduced maintenance and utility costs,
- improved use of family housing to reduce vacancy rates, and
- critical review and validation of construction and repair projects, particularly with an eye to subsequent operations and maintenance costs.

Use of in-house personnel and vehicles for stripping and marking airfield pavements and base roads offered the potential for economy; these tasks had been performed by outside contractors. Another area of savings was the development of a computer simulation program to measure runway roughness.[256]

Additional savings were sought from the closure of some of the dispersed air bases constructed during the 1950s to house B-52 bomber aircraft. Dispersal of aircraft made strategic sense in the 1950s to protect assets from attack. By 1965, missiles had been installed and early warning systems activated. These latter developments supported a move to consolidate B-52 aircraft at fewer bases with no detriment to U.S. defense capability. Reducing the number of physical locations supported by the Air Force provided substantial savings.[257]

Automation

Interest in applying automation to management and accounting for base level civil engineering organizations began in the 1960s. In 1962, development of a standard integrated data automation system to manage all civil engineer functional areas became an Air Force civil engineering objective.

Data automation was adopted for cost accounting and management information. Additional areas for data automation were real property records, master maintenance records, facilities requirements, budgeting, and project reporting.[258]

In September 1964, the Chief of Staff of the Air Force assigned each Air Staff office with the responsibility for developing automation standards, data elements, and data entry codes for their respective functional area. The Plans and Control Division in the Directorate of Civil Engineering took the lead for the directorate. Documenting civil engineering data systems was completed in conjunction with the Air Force's Phase III plan for electronic data processing conversion and standardization of existing data systems at major commands. The Air Staff's Civil Engineering Data Automation Working Group approved the document, which was distributed to each command and used as the basis for programming Standard Civil Engineering Systems at Air Defense Command (ADC).[259]

The Phase II of the Air Force program provided for future base level installation of general purpose electronic data processing equipment, i.e., computers to replace the Burroughs Punched Card Equipment. The Directorate of Civil Engineering began developing specifications for an Integrated Civil Engineering Systems program to ensure that civil engineering requirements were included on the upgraded all-purpose base-level computer. Kelly AFB, Texas, under AFLC, was selected as the test base for system development. The system integrated all civil engineering functions and the data bank included: real property records, labor utilization, work scheduling, control and production, workload programming and analysis, construction control and status, cost accounting, work measurement and labor standards, and budget and funding. The civil engineer supply liaison team collaborated with the supply systems development group to assure an effective interface between the Air Force standard base supply system and the civil engineer cost accounting system.[260] These efforts marked the beginning of the development of the civil engineer Base Engineer Automated Management System (BEAMS). Work on BEAMS started December 1964 and was 20 percent complete June 30, 1965. The estimated completion date was June 1968.[261]

Special Order G-30, issued in June 1966, established the Civil Engineer Data Systems Design Office, a field extension of the Directorate of Civil Engineering. This office was staffed with 13 civilian positions and collocated with the Air Force Data Automation Directorate at Suitland, Maryland. The office had a twofold mission: to design and implement BEAMS and to maintain and enhance the system through additional data systems to support civil engineering at base and major command levels.[262] In October 1967, the Civil Engineer Data Systems Design Office merged with the newly formed Air Force Data Systems Design Center, but the mission of the office remained focused in the development of BEAMS.[263]

BEAMS was designed to be a "complete management system" for the base civil engineer. General Curtin described the system:

> BEAMS is a resource management system which provides the necessary tools for the base civil engineer to totally manage all his resources. It provides management information for the base civil engineer on planning, scheduling and controlling of the facility maintenance workload, family housing management, cost accounting and mechanization of real property records.[264]

BEAMS was intended to eliminate manual record keeping for many, if not all, base civil engineering functions and to realize savings in personnel time. The program was designed to provide current information on costs, labor utilization, and real property records maintenance, as well as generate reports required by higher headquarters.[265]

The Air Force selected the Burroughs B-3500 computer to replace the Burroughs B-263 then in use at 135 bases. BEAMS underwent field testing during 1968 at TAC's Langley Air Force Base, Virginia.[266] At that time, BEAMS was programmed with the following subsystems: Labor, Work Control, Cost Accounting, Real Property Accounting, and Family Housing.[267] The Langley AFB trial identified 80 applications that required correction prior to certifying the system for Air Force-wide use. In addition to corrections, the system was modified substantively to integrate civil engineering cost data with cost data maintained by financing and accounting. While corrections and modifications to the overall BEAMS program were addressed, the module for real property management was implemented as a stand-alone system. A second test of BEAMS was conducted during December 1969 at March Air Force Base, California, a SAC base. Problems still were identified as a result of this field test but many were explained as user errors and due to the capacity of the small test computer.[268]

A third test occurred at Lackland AFB, Texas, an ATC base, during March 1970. The system performed successfully. By April 1970, BEAMS was accepted as a standard operational system. After April 1970, BEAMS began to be widely implemented. The system was installed at Myrtle Beach AFB, South Carolina, in July 1970, and at the U.S. Air Force Academy, Colorado, in August 1970.[269] As of the end of December 1970, 11 major commands had initial implementation/conversion briefings and 28 bases actively were using BEAMS programs on B3500 computers.[270] By the end of June 1971, BEAMS was implemented at 70 bases. BEAMS was projected to be completely operational at the remaining 49 bases by June 1972.[271]

The advantages of BEAMS were numerous. The system provided current data on costs, labor utilization, and real property, in addition to producing automatically selected reports required by higher headquarters. The system's 60 products supported civil engineers in managing their organizations. Among these products were weekly schedule reports on shop activity, monthly in-service work plan reports detailing estimated work and actual work completed, base civil engineer work orders detailing all approved work orders, work order backlog reports detailing man-hour backlog of work, and material due in lists on materials requisitions but not yet received.[272]

Another computerized program of interest to Air Force civil engineers was computer-aided design. In December 1970, a proposal to acquire a computer-aided design program was approved by the Air Staff and forwarded to the Directorate of Data Automation. The initial proposal was to lease two remote computer terminals for lead bases in two major commands for the first year, followed by the installation of 98 terminals the following year. The remote terminals were planned to access a system installed by AFLC at Wright-Patterson AFB, Ohio. In 1971, teletype terminals were installed at Scott AFB, Illinois, and Bergstrom AFB, Texas, which were connected to the Third Generation CREATE (Computational Resources for Engineering and Simulation, Training and Education) computer at Wright-Patterson AFB. Two other terminals installed at Columbus AFB, Mississippi, and Bolling AFB, D.C., were connected to the computer at Rome Air Development Center, New York. The pilot program was tested to determine the number of man-hours that could be saved through use of computer-aided design at the base level. The terminals provided access to 38 computer programs for designing building components of buildings.[273]

Environmental Planning

Since the inception of the Air Force, base commanders and civil engineers have embraced their stewardship responsibilities. From the offset of the environmental movement, the Air Force was quick to comply with environmental legislation. In 1948, the U.S. Congress passed the Federal Water Pollution Control Act (FWPCA); this act established "a national policy for the prevention, control and abatement of water pollution."[274] Additional environmental legislation mandating Federal agency action included the Air Pollution Control Act of 1955 and the Federal Water Pollution Control Act Amendments of 1956. These laws established the authority for action by the Federal government in pollution control, especially in issues of public health.[275]

Eglin AFB, Florida, was the first installation to implement a fish and wildlife conservation program in 1950. Congress was so impressed with the program, that in 1960, a law requiring similar programs was passed for all military installations. The Air Force published its policy, AFR 93-14, Game Law Enforcement and Wildlife and Conservation on Air Force Installations, in June 1954.[276] Two years later, the Air Force and Bureau of Sports Fisheries and Wildlife partnered to "develop and maintain the fish and wildlife resources" located on the Air Force's 6.5 million acres.[277]

In 1953, the Air Force Real Estate Division assigned a liaison to the Department of the Interior to arbitrate matters regarding military activities and impacts to wildlife and other resources under the DOI jurisdiction.[278] The liaison also served as a member on the National Aviation Noise Reduction Committee, subcommittee Group "D" Location of Airports.[279]

Anticipating greater national concern for environmental issues, the Director of Civil Engineering formed a Natural Resources Conservation and Management Panel during the second half of 1965. The panel's objectives were to formulate natural resources policies for implementation on Air Force property, as well as support the DoD Natural Resources Group established in 1964. The DoD's Natural Resources Group was formed to provide assistance in the stewardship of natural resources.[280] The civil engineer panel comprised personnel versed in fish and wildlife management and in pollution abatement. Studies on these subjects were supplied by the Inspector General and the Surgeon General respectively. Programs under the direction of the Air Force panel included forest resources management; abatement of air, soil, and water pollution; land beautification; land and water management; fish and wildlife management; pest control; and outdoor recreation.[281] The Air Force began a reforestation program meeting the best practices of the natural resource management and conservation field. For FY67 and FY68, the Air Force reforested 15,562 acres.[282]

In conjunction with Executive Order 11258, Prevention, Control, and Abatement of Water Pollution by Federal Authorities (November 1965) and Executive Order 11282 Prevention, Control, and Abatement of Air Pollution by Federal Authorities (May 1966), the Air Force published AFM 85-11A, a directive on air pollution control. The Air Force began to monitor and to control discharges from its incinerators, as well as to monitor sulfur content released from coal and oil.[283] In 1966 with the issuance of Environmental Pollution Control Directive, Air Force civil engineers undertook base surveys to determine levels of ground and water pollutants and investigated measures to eliminate and treat contaminants.[284] For FY68 MCP, Congress approved funds for 60 measures in the Air Force's budget devoted to water pollution control and 5 of 6 measures related to air pollution control. These 65 items accounted for 3.6 percent of the Air Force budget.[285]

Two important pieces of legislation related to environmental issues were enacted into law during the 1960s: the National Historic Preservation Act (NHPA) of 1966 (16 U.S.C. 470) and the National Environmental Protection Act (NEPA) of 1969 (42 U.S.C 4321-4347). Each act required action on the part of the Air Force to comply with the new legislation.

The NHPA declared that it was the policy of the Federal government to provide leadership in the preservation of prehistoric and historic resources and to administer Federally-owned or controlled prehistoric and historic resources "in a spirit of stewardship for the inspiration and benefit of present and future generations." The NHPA established the National Register of Historic Places administered by the Department of the Interior. The National Register of Historic Places was composed of sites, districts, buildings, structures, and objects significant in American history, architecture, archeology, engineering, and culture. The act also established the Advisory Council on Historic Preservation, state historic preservation officers, and Federal historic preservation officers. Section 106 of the law required Federal agencies to take into consideration the potential effects of an undertaking on resources included in or eligible for inclusion in the National Register of Historic Places. This required a program of inventory and evaluation resources to determine historic significance for inclusion in the National Register of Historic Places.[286] In May 1971, Executive Order 11593, Protection and Enhancement of the Cultural Environment was issued. This executive order directed all Federal agencies to comply with the provisions of the NHPA.[287]

NEPA, which became effective on January 1, 1970, declared that it was "national policy to encourage productive and enjoyable harmony between man and his environment." It was the intent of NEPA that environmental factors received equal consideration along with other factors in the decision-making processes of Federal agencies, including the military. NEPA established the requirement for Federal agencies to consider environmental effects through preparation of environmental assessments (EA) or environmental impact statements (EIS) prior to making a decision to proceed with the action, including receiving funding from Congress when a particular project required it. Environmental analysis was required to present a quantified prediction of all potential environmental effects of a proposed action, including its alternatives which achieved the proposed action. After review of the EIS, the decision-maker was required to document a rationale for the proposed action or alternative selected. The act established the Council on the Environment to advise the U.S. President on national environmental policy, to publish guideline procedures for preparation of Categorical Exclusions, Environmental Assessments, Findings of No Environmental Impact, as well as EISs by Federal agencies. In addition, the preparation of the annual environmental quality report was required.[288]

In addition to NEPA, the Intergovernmental Coordination Act of 1968 became a relevant part of implementing NEPA, particularly for the Environmental Impact Statement process. The President's Office of Management and Budget issued Circular A-95 establishing broad guidelines for coordination of actions with state and area wide "clearinghouses" for proposed federal actions. Although A-95 was rescinded by President Reagan in 1982, the final rules implementing Executive Order 12372 stated that one of the responsibilities of the secretary of a federal agency was to "communicate with State and local elected officials as early in the program planning cycle as is reasonably feasible to explain specific plans and actions," which was the underlying purpose of A-95.[289]

The increasing role of environmental issues resulted in the removal of the natural resources mission from the Office of the Inspector General to the Directorate of Civil Engineering on July 1, 1969. Under the Directorate of Civil Engineering, the natural resources office coordinated all related Air Force programs including forestry, fish and wildlife, pollution, soil management, pesticide problems, and bird/aircraft strike hazard (BASH). By 1969, historic resources also were included under the environmental program. In 1969, a 600-acre district at F.E. Warren AFB, Wyoming, was listed on the National Register of Historic Places.[290]

As required by NEPA, the Air Force began considering the effect of its actions on the environment and undertaking pre-action planning to minimize those effects. For actions projected to have a significant adverse environmental effect or for actions projected to have controversial environmental effects, the Air Force prepared environmental impact statements, as required by NEPA, that described the action's likely impact, unavoidable adverse effects, alternatives, short-term and long-term effects, and "an inventory of irreversible and irretrievable resource commitments." The impact statements were evaluated by the President's Council on Environmental Quality.[291]

Efforts throughout the 1970s focused on compliance with the pollution legislation and regulations. Use of mercurial pesticides was suspended and concerns over fuel dumping by jet aircraft resulted in several reports to Congress.[292] Converting heating plants from coal to low-sulfur coal or to natural gas was investigated to reduce air pollution generated by the Air Force. However, in 1973, all plants under design to convert coal-fired heating plants to other fuels were directed to remain on coal because of the energy crisis and shortages of gas and oil. Other areas of attention included aircraft emissions; jet engine test cells; and automotive vehicles.[293] On February 4, 1970, President Richard Nixon signed Executive Order 11507 which expanded pollution control to include Federally owned and operated "aircraft, vessels, and vehicles…from which air and water pollution must be abated, prevented, or controlled."[294]

The increased number of Executive Orders (EOs) and directives for environmental management led to the establishment on July 24, 1970 of the Environmental Protection Group.[295] Staffed by three officers and eight civilians, the new group assisted the Air Force in executing its environmental responsibilities and ensured compliance with NEPA, EOs, and regulations on environmental quality and pollution abatement.[296] A workshop was held in September 1970 for all command environmental protection coordinators. Seventy-six Air Force personnel attended the workshop, which was devoted to responsibilities under NEPA, as well as the guidelines set forth by the Council on Environmental Quality.[297]

The Resource Recovery Act (RAA) of 1970 recognized national support for recycling programs across the country. The RAA increased Federal authority in waste management and emphasized waste reduction and recovery through recycling.[298] Seven major commands were directed to select two of their bases as hosts for a pilot recycling program by the end of December 1971. After the six-month recycling program, the 14 installations evaluated the "availability of markets for recycling glass, paper and metal; impact in family housing areas of separating refuse into separate containers; and the economic aspects of the program." The results were mixed but the test offered several recommendations for any base wishing to begin a recycling program.[299]

All functions were scrutinized for environmental consequences. Cleaning products used by the Air Force were inspected and several were found to have adverse impacts on the environment. Ecologically unsound products included the chemicals used to strip rubber buildup from runways. Such stripping was a safety necessity since rubber slick runways were linked to hydroplaning. The Environmental Health Lab and the Air Force Materials Lab tested alternatives until an acceptable cleaner was developed in 1971 that met pollution abatement standards.[300]

On April 12, 1971, 50 Air Force civil engineers participated in the first Environmental Protection Course at AFIT's Civil Engineering School. The introductory course provided an overview of environmental laws and policies. Air Staff published AFR 19-2, Environmental Assessments and Statements to assist major commands to comply with the NEPA process. The regulation provided the steps for developing EAs and EISs including Air Force actions requiring such studies.[301] The move towards energy conservation impacted construction projects on the base-level. Initiatives were adopted to renovate existing buildings or retrofit building systems using energy-saving practices rather than erect new buildings.[302]

In 1972, the Air Force developed an Oil and Hazardous Substances Pollution Contingency Plan. The plan implemented pollution spill response provisions and established a facilities surveillance program for detecting conditions that could lead to pollution spills. New installation standards also were established for petroleum, oils, and lubricants (POL) facilities. These facilities comprised pressurized hydrant fueling systems, pressurized hot fueling systems, and underground steel tanks. The new POL standards replaced earlier standards that were 20 years old.[303]

In January 1974, the Air Force published its pledge to environmental protection. The Environmental Planning Division (AF/PREV) was established later that year under the Directorate of Civil Engineering. The division was divided into two branches: Air Base Planning and Development Branch (AF/PREVX) and Environmental Policy and Assessment Branch (AF/PREVP).[304] A full-time Environmental Coordinator was established at most Air Force bases as well. An Environmental Planning Activity at the Air Force Civil Engineering Center, Tyndall AFB, was then established with the purpose of planning, organizing, and assisting major commands and using agencies.[305]

In 1974, the Air Force announced the proposed to move of the Air Force Communications Service from Richards-Gebaur AFB near Kansas City, Missouri, to Scott AFB in Illinois, east of St. Louis. The local city governments and counties sued the Air Force for not filing an EIS on the action and the district court enjoined the Air Force from proceeding with the move on the basis of not considering the socio-economic impacts of the move. Under the direct management of the Air Base Planning and Development Branch an EIS was prepared and successfully defended in federal courts against lawsuits and appeals by a consortium of the states of Missouri and Kansas as well as the cities and counties in both states surrounding Richards-Gebaur AFB. The EIS for this action was regarded by many at the time as the first predominantly socio-economic impact EIS ever prepared by a federal agency and the process became a milestone for socio-economic, as well as bio-physical evaluations in EISs. It also validated the need for comprehensive environment planning and decision making across the Air Force.[306]

United States Air Force Pledge to Environmental Protection 1974

The United States Air Force is dedicated to National Defense. Inherent in this dedication is the commitment to protect our environment, to conserve energy and to preserve our natural resources. To this end, each of us pledge to…

- Wholeheartedly support and demonstrate leadership for National Objectives to protect, preserve and enhance the environment.
- Evaluate honestly and conscientiously each proposed Air Force action for environmental consequence as an integral part of the decision process.
- Comply fully with the most stringent Federal, State and local environmental standards.
- Actively support and participate in Air Force programs for environmental protection – a goal as fundamental as life itself.
- Reverse trends in growing energy use without compromise of readiness, or lessening of our ability to fly and fight.
- Encourage cooperation in community efforts to control and abate pollution both on and off our Air Force installations.

Signed January 16, 1974 by John L. M. Lucas, Secretary of the Air Force and Gen. George S. Brown, Chief of Staff, U.S. Air Force[307]

Air Installation Compatible Use Zone (AICUZ)

The Air Force continued to work on challenges of encroachment of neighboring civilian communities in the proximity of installations and the effects of aircraft noise. The Greenbelt Concept was developed in early 1971 by the Office of the Secretary of Defense and the Air Force as an initiative to control land use, and possible encroachment, surrounding installations through such tools as easements and zoning. Later that year, the name of the program was changed to avoid potential confusion with the White House's Greenbelt proposal for city parks.[308] The Air Force program, renamed Air Installation Compatible Use Zone (AICUZ), focused on defining appropriate installation buffer zones based on three major operations factors: noise levels, airfield and air space requirements, and accident hazard potentials. The U.S. Congress approved the AICUZ concept in the FY73 MCP.[309]

All installations were mandated to report aircraft flight patterns, flight profiles, power settings, and ground information for each type of aircraft. Once compiled, the information was sent to the AFCEC at Tyndall AFB, Florida, where data were analyzed using a computer program; analyzed data were then mapped to depict noise contours.[310] The data collection was refined in 1974, when the EPA implemented the Day-Night Average Sound Level System as the national standard for assessing aircraft noise.[311]

The second objective associated with AICUZ was to delineate acceptable heights of construction in the vicinity of airfields. In addition to height restrictions in the vicinity of the airfields, Compatible Use Districts (CUD) were established and recorded on AICUZ maps; each CUD restricted development to the uses acceptable under local zoning. The maps generated under AICUZ assisted in local land use planning and also provided a "basis for residential mortgage insurance evaluations by the Department of Housing and Urban Development and the Veterans Affairs." On-base sites for family housing were selected in response to quality of life considerations.[312]

AICUZ evolved based on the results of earlier studies, including the Composite Noise Rating (CNR) system, the 1964 Land Use Planning with Respect to Aircraft Noise report, and the 1970s Noise Exposure Forecast (NEF).[313] The NEF was created to assess and to calculate noise levels from aircraft operations on the base and within the immediate vicinity.[314] In May 1973, the Air Force Aero

Propulsion Laboratory at Wright-Patterson AFB, Ohio, initiated investigations into noise reduction and emission control for military aircraft systems. The resulting report established goals and included a discussion on the impacts from current and future aircraft.[315] AFCEC assumed responsibilities for compliance with NEF in 1974. NEF contour maps had become a necessary tool for completing environmental assessments.[316]

In the FY73 MCP, $12 million was authorized and $2 million was appropriated for AICUZ projects. The $2 million appropriation was targeted for projects at Altus and Tinker AFBs, Oklahoma, and Williams AFB, Arizona. In the FY74 MCP, $10 million was allotted for AICUZ related projects.[317] The AICUZ policy of 1974 dictated that every base commander institute and maintain an AICUZ program.[318]

In 1974, the Air Force began the Expanded Clear Zone Acquisition program as part of the AICUZ plan.[319] The goal of this new program was explained by Maj. Gen. William D. Gilbert,

> We decided that we'd start a program to buy out parcels three acres wide and three miles long on either end of our runways. If there were houses within those areas, we would buy the homeowners out and then remove the houses. We would set that aside and put it in Air Force hands forever so that no builder could ever encroach our airfields again. We started buying out the worst locations first, and we'd buy out two or three a year…It was bound to be a controversial program, because for one, our air bases had been encroached upon so badly in some locations…that houses were right off each end of the runway.[320]

Property acquisitions were funded beginning in FY76.

Energy Programs

The energy crisis of 1973 affected the Air Force as well as the civilian sector. Presidential orders to decrease energy consumption were issued to combat the effects of the energy crisis. The strategy of reducing Air Force energy consumption also presented opportunities for efficiencies and economies in operations. Energy consumption was supported by the DoD through a series of directives to conserve energy. The Air Force responded with a HQ AF/Directorate of Engineering and Services letter dated April 18, 1973 on the subject Review of the Operating Efficiencies of Heating Plants and Heating System. A second letter dated January 18, 1974 on the subject Reduction of Energy Consumption in Military Facilities followed.[321]

The DoD now competed with the civilian sector for energy. Prior to the crisis, the utility conservation program in the Air Force often was not followed strictly. Lax enforcement was changed quickly during the 1970s. Heating and cooling operations were scaled back during evenings, weekends, and holidays. During operating business hours, thermostats were set at the lowest level consistent with personnel health.[322]

In response to a deepening energy crisis, the Air Staff Force created the Civil Engineering Conservation Task Group in AF/PRE on December 12, 1973. The group led efforts to reduce energy consumption at all installations. A Presidential Memorandum on June 29, 1973 called for all DoD organizations to achieve 7 percent energy reductions for the first and second quarters of FY74. Baseline energy data were obtained from the Air Force quarterly report for August 27, 1973, which included consumed energy for FY73. For July to November 1973, the Air Force realized an 8.1 percent energy reduction.[323] The following year, the DoD established a 15 percent target to reduce energy consumption. Once again, the Air Force exceeded requirements. Energy reduction for January – May 1974 was 16.9 percent followed by 17.5 percent reduction for the period of July – October 1974.[324] A percentage of energy savings came from efficiencies in the operation of military housing. Through such measures as low-flow showerheads, insulation, storm windows, weather-stripping, caulking, and solar screening for glass, the housing sector was able to reduce energy usage.[325]

In July 1974, the Secretary of Defense supported a facilities energy conservation investment program (ECIP). The ECIP evolved from a Defense Energy Task Group recommendation to improve energy reduction in facility systems. Typical projects that were eligible for funding under the program included the installation of storm windows, sunshades, and additional insulation as well as utility load management systems.[326]

The energy crisis spurred research and development into efficient and abundant energy sources. Programs were developed to study nuclear, solar, geothermal, coal, and thermonuclear fusion.[327] During 1975, the AFSC and the U.S. Air Force Academy participated in a joint investigation into the economics, maintenance, and benefits of incorporating solar panels in housing and facility projects.[328] The Energy Research and Development Agency financed the investigation. Grand Forks AFB, Sheppard AFB, Andrews AFB, Offutt AFB, and the U.S. Air Force Academy received the first solar heating systems.[329] Three dormitories and a dining facility at Lowry AFB were the first projects to comply with the provisions of an Inter-Agency Agreement between the Federal Energy Administration and the Air Force. The projects were used to demonstrate energy conservation to other Federal agencies and to the general public. Alterations to the facilities included the installation of entrance vestibules, addition of storm windows, upgrades to lighting, and a complete renovation of the steam heating system.[330] In 1976, the investment in solar technology was not considered "economically justifiable."[331] Civil engineers were advised to weigh the costs of solar equipment and the potential benefits based on sunlight and weather considerations.[332] Although the Air Force deemed photovoltaic cells not to be advantageous currently, research continued based on their potential for future economic viability.[333]

During the mid-1970s, the Air Force undertook several feasibility studies into harnessing alternative energy sources. On April 8, 1975, the Air Force received funds for a pilot program to employ solar energy as the prime energy source for 50 military family housing units in accordance with the Solar Heating and Cooling Demonstration Act of 1974.[334] Other trial programs included processing fuel pellets from solid waste products. In 1975, Griffiss AFB received funding from AFCEC to test the use of pellets for oil-fired boilers.[335]

CONSTRUCTION

Maj. Gen. Maurice R. "Tex" Reilly summarized succinctly the role of the Air Force civil engineer in the Air Force MCP construction program. The Air Force, he wrote, "develops its program, justifies it before the committees of Congress, prepares functional and technical criteria, specifies siting, and exercises client surveillance during design and construction."[336] The Directorate of Civil Engineering was responsible for correlating construction projects submitted by major commands and individual bases. These proposals were prepared in accordance with functional, technical, and siting criteria. Under law, the Air Force was required to use the U.S. Army Corps of Engineers or the U.S. Navy as the construction agents for Air Force projects. In 1974, the U.S. Army Corps of Engineers and the U.S. Navy served as construction agents for 90 percent of Air Force projects. Fifty percent of those projects were designed by architect-engineer firms in the private sector.[337] The remaining ten percent of Air Force MCP projects were projects or programs for which the Air Force had special permission to act as the construction agent or construction projects at overseas Air Force commands where civil engineers oversaw all aspects of the projects.

Air Force civil engineers managed project design and contracting for maintenance and repair projects at the bases and for non-appropriated funds facilities constructed to support morale, welfare, and recreation activities. Approximately 50 percent of this work was designed and constructed in-house, while the other half was contracted out to private architect-engineer firms.[338]

Typically, the design, contracting, and construction of projects were monitored by the Air Force

Regional Civil Engineer (AFRCE) offices. Civil engineers assigned to these offices worked as engineering field managers ensuring that Air Force construction plans and specifications were met by the construction agent for the best dollar value and within the best possible schedule. Led by a staff officer, AFRCE offices were charged with assisting Air Force users in defining facility requirements, preparing design specifications and criteria, reviewing drawings and plans, reviewing contract documents, interfacing with the construction agents, and monitoring actual construction projects. Their area of responsibility extended to most of the Air Force military construction program, with the exception of the missile construction program and overseas construction. Major command civil engineers oversaw overseas construction.[339] In all cases, facilities were turned over to Air Force civil engineers for operation and maintenance.

New construction programs, such as family housing and missile installations, were prominent programs in CONUS in the early 1960s. During the mid and late 1960s, the majority of construction budgets were directed towards projects in Southeast Asia to support the Air Force contingency mission. By the early 1970s, as fewer new facilities were required to bed down new weapons systems, funds were expended to upgrade and modernize Air Force facilities. In FY74, nearly 65 percent of the construction budgets were spent on modernization, repair, and upgrading facilities.[340]

Throughout the period, Air Force civil engineers acquired in-house expertise in design, construction, contracting, and management with the objective of assuming control of Air Force CONUS and overseas projects. The organization had the personnel and cultivated design talent.[341] Early in the 1960s, Air Force civil engineers assigned to the Air Force Systems Command (AFSC) continued their participation in the design of missile launch sites. Air Force civil engineers were directly involved in siting, design, and monitoring construction of missile silos; these launch platforms were integral to the operation of the system. This assignment marked the first time that Air Force civil engineers participated directly in the development of a weapons system. Air Force civil engineers also were deeply involved in monitoring construction of the worldwide communications network. In addition, the Air Force oversaw the construction of several technical facilities, including the Sonic Fatigue Test Facility funded in 1960 at the Wright Air Development Division at Wright-Patterson AFB, Ohio, and the Aeropropulsion Systems Test Facility at the Arnold Engineering Development Center funded and constructed during the 1970s and 1980s.[342] The Directorate of Civil Engineering also served as both the design and construction agent for family housing.

In 1972, Section 704 of Public Law 92-545 authorized the Secretary of Defense to approve the design and construction of MCP projects by agencies other than the U.S. Army Corps of Engineers or the U.S. Navy. The Air Force was granted authority to act as the design and/or construction agent for \$45 million in projects, which represented 15 percent of the FY73 program. Design of those projects was approximately 97 percent complete by December 31, 1972. This approval extended to the following fiscal year and the Air Force was granted design and construction authority in the FY74 MCP for \$33 million in projects, or 12 percent of the total program.[343]

Design and Construction Management

Air Force civil engineering leadership actively sought measures to control design and construction costs. Spending tax payer money wisely and fully justifying construction budgets were consistent themes, particularly in the early 1970s, when economic inflation and spiraling costs squeezed already tight budgets. Air Force civil engineers adopted innovative processes to maximize their construction dollars and streamline the conventional architect-engineer design process. Cost effective tools supporting efficiency included project design books that detailed design criteria, simplified plans and specifications, two-step procurement, one-step turnkey projects, and industrialized construction.[344]

Two-Step Procurement

Two-step procurement secured contractor support for construction projects in two phases. Air Force civil engineers initially prepared project descriptions, defined the government requirements, and distributed statements of work among qualified contractors. Following a mandatory pre-proposal meeting, potential contractors submitted technical proposals detailing their approach to the work for government evaluation. This stage of the process was confined to technical proposals and did not include detailed cost budgets. The Air Force reviewed the technical proposals solely for the ability to meet the project goals. The second phase of the procurement process solicited cost proposals from contractors whose technical proposals were found acceptable. The project was awarded based on the most advantageous cost proposal. The two-step procurement process proved expedient and cost-effective for both the Air Force and civilian contractors. Contractors first were prequalified on the merits of their experience and technical approaches before labor intensive cost proposals were solicited. The two-step procurement assured that the Air Force received technically competent and cost effective contractor support, while encouraging contractor innovation and eliminating the necessity of labor-intensive designs early in the bidding process.[345]

The two-step procurement process was used at Wright-Patterson AFB, Ohio, an AFLC base, as early as 1963. Initially, the two-step procurement process was restricted to projects under $25,000. By eliminating the development of project plans and specifications by Air Force personnel, the process reduced Air Force labor costs associated with project procurement by an estimated 60 percent and also reduced the number of project change orders during project execution. The process did, however, extend procurement schedules. It took approximately 20 days longer to procure contractor services. In 1964, Air Force civil engineers at Wright-Patterson AFB used the two-step procurement process for 20 projects and reported favorable results. The process was used to secure contractors for repaving parking lots, roofing, boundary fence installation, and many types of repair and alteration projects.[346]

The Air Force applied the two-step procurement process to the construction of buildings and facilities when the process saved design and/or construction time without sacrificing quality, or where the unique requirements of a project and a bidder's specialized equipment or systems became a determinant in the design of the end product. In FY69, the two-step procurement process was used to contract for the construction of a C-5A maintenance dock and hangar at Dover AFB, Delaware. In FY70, C-5A facilities at Kelly AFB, Texas, and Altus AFB, Oklahoma, were also candidates for two-step procurement, as was the commissary and cold storage facility at George AFB, California. The two-step process at Dover AFB saved 11 months of design time and nearly $160,000 in design funds. The design and construction occurred concurrently.[347]

Two-step procurement was used to contract the construction of family housing at several bases with mixed results. Civil engineers with the Tactical Air Command successfully used the two-step procurement process to contract for the construction of 150 family houses at Luke AFB, Arizona, and 100 houses at Bergstrom AFB, Texas. TAC civil engineers reported savings achieved through reduced project costs and an early completion date.[348] By 1972, 2,600 family housing units had been built using the two-step procedure. The FY72 family housing program for the construction of 2,910 units at nine bases was advertised under the two-step turnkey procurement. All bids received exceeded the government estimate and the procurement was withdrawn. Several problems were identified with the project, including the government requirement for relocatable housing, bids for individual bases were not permitted and, in this case, the two-step procurement process was inflexible and time consuming. Additionally, design criteria based on achieving performance specifications in the first step of designing with budgets unknown to contractors, often resulted in bids which exceeded budgets as explained below. The contract to construct the housing units was re-advertised within two months using One-Step Turnkey procedures.[349]

Industrialized Construction

While Director of Civil Engineering, General Goddard promoted industrial construction as an approach to solving the large Air Force family housing shortage and to containing rising construction costs. Through the use of modular units, industrial construction also provided flexibility and the potential to relocate completed buildings. General Goddard reflected on these latter advantages,

> We have been wedded in the past to fixed facilities which, due to changes in base structure and fluctuating populations, many times turn out to be in the wrong place. Relocatable structures, used extensively in Southeast Asia and for interim applications in the CONUS, prove that certain facilities can be constructed and relocated on an economic basis.[350]

In August 1970, a special task force, known as the "Mod Squad," was created to investigate the capabilities of the prefabricated building industry and to identify the types of Air Force facilities that could be housed in modular structures. The task force also was tasked with determining the feasibility of creating a new generation of relocatable facilities for CONUS application. The group was led by then-Lt. Col. George Ellis and included Lt. Col. Don Youatt, Maj. John Pearman, and Mr. Larry Hoffman. The task force was assisted by the architect-engineer firm of Heery and Heery from Atlanta, Georgia. The resulting study concluded that relocatable facilities assembled from factory-fabricated components or modules had the potential to provide significant construction savings. The task force recommended that industrialized construction be adopted for Air Force bachelor housing, for operational, administrative, and training facilities, and for warehousing.[351]

A second study on modular design was awarded to Rensselaer Polytechnic Institute's Center for Architectural Research on June 30, 1971. The purpose of this study was to conduct analysis, research and systems evaluation of modular relocatable structures and to provide the CEC with research and design guidance for modular construction for a variety of uses.[352]

Armed with the findings of these two studies, the Directorate of Civil Engineering requested that the Air Force be assigned design and construction management responsibility for $43 million in the FY72 MCP to construct relocatable buildings at Air Force bases, including for the family housing program. The Secretary of Defense approved the industrialized building concept but assigned design and construction responsibility to the U.S. Army Corps of Engineers.[353]

The promising program did not yield the projected results for family housing. The private sector was not geared to the production of the industrialized/relocatable military family housing envisioned in the FY72 MCP program. Lack of industry experience resulted in excessively high cost proposals and a lack of competitive interest. Accordingly, housing projects were re-advertised using one-step procedures, which deleted the relocatability requirements. Procurement for the FY72 industrialized family housing program terminated in July 1972.[354]

One-Step Turnkey Procedures

One-Step Turnkey procedures were competitive procurements that required all bidders to submit detailed designs which fulfilled the government requirements and technical performance specifications detailed in a project statement of work. Designs were evaluated by Air Force architects and engineers for meeting the Air Force statement of work and graded for quality, particularly when the designs exceeded quality or minimum scope requirements. Quality points were assigned by the evaluation team within prescribed allocations by area. A separate source selection committee would then match the quality points against the prices offered to assign cost per quality points and recommend a selection to the source selection authority, often a general officer and usually the MAJCOM commander. This system created competition among contractors who were free to submit proposals that exceeded the minimum project requirements provided that their base design met the performance specifications and was within the stated Air Force project budget. The One-Step Turnkey approach first was used in 1966 in the design and construction of Air Force family housing at Peterson AFB, Colorado. One-Step Turnkey procedures were used again for family housing projects in 1972. In the 1972-73 time frame, the national procurement for 3600 family housing units in a two-step process for modular relocatable units exceeded their statutory cost. This program had to be re-procured and the One-Step Turnkey process was used to award the program before its statutory authority expired. Simultaneously, the next year's program had to be re-configured to use the One-Step Turnkey process. Between 1972 and 1974, 6,000 family houses were constructed using One-Step Turnkey procedures all within statutory time constraints.[355] The turnkey process also was expanded to other types of construction projects, such as the development of Tuy Hoa AB in the Republic of South Vietnam.

CONUS Construction: Major Command Programs

The following sections highlight selected major construction projects and programs between 1960 and 1974.

Air Force Systems Command and the Missile Program 1960-1974

Established in 1961, Air Force Systems Command (AFSC) was the successor to the Air Research and Development Command. AFSC served as the design and/or construction agent for some of the largest, most technologically challenging, expensive, and exciting programs and projects of the time period. These projects included missiles, sophisticated communications systems, and space launch facilities. Air Force civil engineers were assigned in sizeable numbers to the Aeronautical Systems Division (ASD), Electronic Systems Division (ESD), Ballistic Missile Division (BMD) and Space Systems Division (SSD). In 1967, the Ballistic Systems Division, which succeeded BMD, and SSD were combined in the Space and Missile Systems Office. The civil engineer's role in these divisions was to "plan and develop the test and operational facilities required for the weapon systems being developed by the product divisions."[356] Each division included a Directorate of Civil Engineering to manage the programming, engineering, and the design, construction, and maintenance of facilities.[357] Many young officers who served in these directorates, including then 2d Lt. Joseph A. Ahearn, were afforded opportunities to assume high-levels of professional responsibility relatively early in their careers.[358]

In FY62, 53 percent of the military construction budget was directed towards missile bases. The Ballistic Systems Division (BSD) of AFSC served as the design agent for the Atlas and Titan intercontinental ballistic missile (ICBM) underground silo launch facilities. Air Force civil engineers in BSD and architect-engineer firms under contract to the Air Force solicited design criteria from a variety of agencies, coordinated requirements, established design interfaces, developed designs, and produced plans and specifications for this complex construction project.[359] Air Force civil engineers, along with civilian consultants, also designed the environmental controls, power production, and fueling systems for the launch complexes.[360] According to Capt. R.C.B. Wright, who served as Project Engineer for Titan II facilities with SSD:

> The Air Force Civil Engineer is an integral part of the team developing the Air Force Titan III Standard Space Launch System. He is essential to overall planning for meeting program objectives; this is the only way he can fulfill his obligations to the program. The Civil Engineer's mission is to assure construction of fully functional and operable facilities designed and constructed to meet system requirements and built within the close time/cost limits dictated by system objectives.[361]

The Air Force turned construction of ICBM facilities and launch sites over to the U.S. Army Corps of Engineers after the Air Force approved the plans. Both the U.S. Army Corps of Engineers and the Air Force anticipated that construction of the facilities would be fairly straightforward based on approved designs. However, the results of ongoing ICBM testing prompted changes in the design of the launch silos. As a result, the U.S. Army Corps of Engineers was forced to change the design of the ground complexes already under construction and often redesigned newly completed buildings. By April 1962, the U.S. Army Corps of Engineers had submitted 2,676 change orders to awarded contracts. The cost for these changes totaled approximately $96 million.[362]

The construction of multiple missile installations across the country was a complex project involving U.S. Air Force and U.S. Army Corps of Engineers personnel; numerous civilian construction contractors; and hundreds of subcontractors, suppliers, manufacturers and unions. In early 1960, the construction program was mired in delays; project management was an administrative maze. General Curtis LeMay, the Air Force Vice Chief of Staff, appointed eighteen senior Air Force colonels, as the responsible authorities at the intermediate headquarters and at each installation. These former pilots possessed demonstrated administrative skills and the drive to advance the project. This group of colonels served as the Site Activation Task Force to ensure that the missile bases were built.

By 1962, SAC had activated 13 Atlas squadrons and 6 Titan I squadrons in the United States. The number of missiles within each squadron varied from 6 to 12. Locations where missiles were activated included California, Wyoming, Nebraska, Colorado, Washington, Kansas, South Dakota, Oklahoma, Idaho, Texas, New Mexico, and New York. That same year, the Air Force placed the first ten Minuteman ICBMs, located at Malmstrom AFB, Montana, on alert.[363]

In 1962, the American Society of Civil Engineers' (ASCE) awarded its Outstanding Civil Engineering Achievement of the Year to the U.S. Air Force ICBM program. Air Force civil engineers were recognized for their role in the planning stages in the installation of the new weapons systems, an accomplishment of notable complexity and magnitude.[364] In a presentation before individuals involved in the project, W.H. Wisely, Executive Secretary of ASCE, stated that, "working before the eyes of the world as you do, gentlemen, you have received a good deal of expert advice and more or less justified criticisms from many quarters. It is fitting—for a change that tonight you are to be honored for a job well done."[365]

Robert J. Alexander, who served as the Principal Engineer at SSD, noted that by the beginning of 1963, the SSD Directorate of Civil Engineering had "programmed, engineered, and managed the design, construction, and maintenance of $51 million worth of facilities for the Air Force Space Systems at 13 world-wide locations."[366] Alexander enumerated the responsibilities of the SSD civil engineer:

- Anticipate facilities requirements and accomplish programming and advance planning on a timely basis.
- Assure adequate MCP (Military Construction Program) and O&M (Opera tion and Maintenance) program coverage for facilities to meet multiple systems objectives.
- Obtain appropriate design and construction authorizations from higher head quarters to ensure that facilities planning and building proceeds in phase with over-all systems time requirements.
- Select and procure the services of qualified architect-engineer firms to accomplish engineering studies and designs, and plans and specifications. The CE must also direct, manage, technically review, and evaluate the A-Es work.
- Keep continuously informed of technological advances in systems developments and assure that facilities design is closely correlated with systems requirements.
- Ensure that each design is technically corect from a civil engineering point of view, that it provides for a totally operable and maintainable facility, and that

it represents an economical and constructable work package.

- Establish and maintain adequate controls (through the Air Force Regional Civil Engineer or overseas Command with AFRCE functions) to assure that the construction agency awards the facility construction contracts promptly and accomplishes quality construction on schedule.
- Direct and monitor maintenance of the facilities and real property sub-systems.
- Be capable of applying advanced technology in engineering practice, design techniques and construction methods to the complex and often unique facilities that he designs and builds for the Air Force R&D Space Programs. An important corollary calls for the SSD Civil Engineer to provide, on call, engineering consultant service to all AFSC Divisions and Centers for review of criteria and design of space mission oriented facilities projects.[367]

By February 1963, a successful Titan II test flight was completed. By December of the same year, six Titan II squadrons were on alert.[368] Deployment of the newly developed missiles was made possible, in part, by civil engineers. As the Chief of the Power Production Branch for the Department of Civil Engineer training at Sheppard AFB, Maj. Bill E. Polasek, Jr., explained, "if the United States is ever required to launch an ICBM in retaliation, the ability of that ICBM to reach its target will partially depend on well trained Civil Engineer personnel."[369] The typical civil engineer officer assigned to maintain missile bases performed a variety of duties. These duties included ensuring sufficient water, inspecting and maintaining Real Property Installed Equipment (RPIE), such as launch equipment and air conditioners, and monitoring the corrosion control program.[370] Controlling water inside the silos was especially challenging and special teams, known as SAC grout teams, were formed to maintain the integrity of the silos.

SAC Grout Team

Numerous technicalities were associated with the Minuteman Missile systems. In particular, the underground silos presented challenges due to their location beneath the ground water table. SAC grouting teams were created in 1962 at Larson AFB, Washington, to address leaks at Titan I locations. Once the Titan was considered obsolete, these teams were reassigned to repair Minuteman Missile facilities. Water infiltration caused damage and created an environment for corrosion. SAC's grouting team provided a remedy to the problem. Previous unsuccessful attempts to correct the water seepage included the use of glues, welding, and concrete. The SAC grout teams traveled to various bases to provide assistance. They often requested the help of civil engineers and missile engineers on base in order to complete the job. Existing leaks were repaired with the use of chemical grout, which was pumped into seams; potential leaks were also addressed using hammers to detect voids between steel and concrete. Holes were then drilled to allow the pumping of grout into the problem area.[371]

By 1971, the military was investigating a replacement for the Minuteman; SAC considered the system outdated. SAC ideally sought a replacement missile with a larger range and greater precision; the capability to launch several independent warheads at one time also was desirable. In spring 1972, development began on the "Missile-X" (MX). As the Soviet missile program grew to include ICBMs, the U.S. questioned the ability of its silo-based missiles to withstand a Soviet assault. As a result, hardened silos were adopted and air-mobile systems were contemplated.[372]

Military Airlift Command (MAC) Terminals

With the buildup of U.S. forces in Southeast Asia, MAC assessed its passenger and air cargo terminals worldwide in the mid-1960s. Many MAC terminals were constructed during World War II. These World War II terminals were unable to support the high volume of traffic destined for Southeast Asia. MAC began a multi-year program to upgrade its system of passenger and cargo terminals. New passenger terminals were constructed at Yokota AB, Japan; Norton AFB, California; and, McChord AFB, Washington. The designs of these terminals incorporated separate facilities for inbound and outbound passengers.[373]

MAC and Air Force civil engineers planned a modern passenger terminal to replace the older passenger facilities at Rhein Main AB, Germany. Rhein Main AB was the main European terminal for arriving U.S. military personnel. Operations for the old Rhein Main AB passenger terminal were dispersed across the air base in three different facilities. The inbound terminal operation was located in the freight terminal, the outbound terminal procedure was part of the Base Operations facility, and the terminal offices and check-in were located at the Base Hotel. These operations were consolidated in the new terminal. The base civil engineer prepared the programming documents. The U.S. Air Forces in Europe (USAFE) issued the design instruction and the construction contract was awarded to the architect-engineer firm of McGaughy, Marshall and McMillan of Athens, Greece. The modern 63,500-square foot terminal opened on June 17, 1972. Rhein Main AB's new passenger terminal included state-of-the-art technology and customer-friendly services within a single facility. The terminal included telescopic passenger loading/unloading bridges, mechanized baggage handling systems, television monitors with current flight information, security surveillance, and transit lounges.[374]

Air cargo terminals also required modernization to accommodate the all-jet fleet, which included the new C-141 and C-5 aircraft. The C-5 aircraft held 10 times more freight than the C-54s, the aircraft for which the terminals originally were designed. Although freight terminals had been expanded over the years, additional capacity was needed to efficiently handle the C-5s. MAC was assigned the design authority for the terminals, and, in 1968, MAC civil engineers contracted with Dortech Inc., a specialist in aircraft handling systems, to develop a series of three definitive designs. The terminal designs were for small inland terminals handling between 200 to 600 tons per day, medium terminals handling between 1,000 to 2,000 tons per day, and large terminals handling between 3,000 and 6,000 tons per day. MAC staff, including the civil engineers, consulted with the architect-engineer firm to develop the best design. Design criteria included integration between the facility and the materials handling system, flexibility to accommodate changes in operations, the ability to expand through the installation of modules without disrupting operations, and costs.[375]

MAC approved the final definitive designs in May 1969. MAC served as the design agent for the first terminal, which was constructed at Travis AFB, California and funded in FY70. Travis AFB was a port of debarkation for the West Coast. The design of the freight terminal at Travis AFB was a 200 x 1,083-foot rectangle with truck docks, pallet pits and pallet buildup stations, pallet storage, mobile cargo handling equipment, and a sophisticated mechanized materials handling system. In addition to the new freight terminal, extensive work was undertaken on the runways, taxiways, and parking aprons, as well as new fuel and fire protection facilities. Other new freight cargo terminals were planned for construction at Dover AFB, Delaware, in 1973 and RAF Mildenhall, England, in 1974. Terminals programmed for alterations included Charleston AFB, South Carolina, and Norton AFB, California.[376]

Air Force Logistics Command (AFLC) Depot Modernization

The five-year depot maintenance modernization program overseen by Air Force civil engineers in AFLC was one of the largest construction projects to occur during the early 1970s. AFLC's mission was to provide logistical support and materiel to the operational forces. In 1973, AFLC supported and maintained 12,697 aircraft, more than 38,000 jet engines and 12,000 reciprocal engines, over 1,000 missiles, and over 80,000 separate line items of equipment. By 1970, the number of depots in AFLC had decreased from nine to five depots; increased workload resulted in overcrowded conditions. The depots were industrial complexes incorporating buildings housing aircraft maintenance, as well as engine and equipment repairs. Depots also included materials distribution buildings for storage, equipment management, packaging, and transportation activities. By 1970, these buildings, some dating from World Wars I and II, were considered substandard and outdated.[377]

In 1970, AFLC civil engineers, maintenance, distribution, and materiel management personnel developed the modernization program for the five depots. AFLC worked with the service engineering contractor, Tate Technical Service, Inc., from Glen Burnie, Maryland. The goal of the depot modernization program was to construct state-of-the-art industrial buildings with up-to-date equipment and materials handling procedures to increase efficiencies and maximize productivity. The program encompassed new construction and installation of up-to-date machinery and handling systems. Air Force civil engineers fully justified the program through an extensive cost-benefit analysis. The formal modernization program was slated to begin in FY72, but the FY71 MCP contained $23 million for construction projects. One $15 million project in FY71 was the construction of a 543,000-square foot aircraft engine overhaul facility to consolidate work formerly conducted in nine separate buildings. An innovative design developed under the program was the logistical materials processing facility, which was constructed at four depots. The new facility consolidated the activities of receiving, unpacking, identifying, routing, corrosion protection, packing, and shipping in one facility using modern mechanized handling and processing systems.[378]

By 1973, AFLC had constructed 29 new facilities at the following depots: Kelly AFB, Texas; Hill AFB, Utah; Tinker AFB, Oklahoma; Robins AFB, Georgia; and, McClellan AFB, California. The Air Force civil engineers estimated the total cost of construction program at $250 million. Funding requested was $52.5 million in FY72; $31.4 in FY73; $31.4 million in FY74; $45.5 million in FY75; and, $21.6 million in FY76.[379] Yearly appropriations were less than requested and the modernization program was extended to 1978, beyond the original five-year plan.

Temporary Living Quarters

In 1970, the Air Force implemented a new housing program, Temporary Living Quarters (TLQs), to accommodate personnel and their families during permanent change-of-station moves. TLQs were on-base, low-cost housing options for military personnel waiting for permanent housing. On October 9, 1970, approval for $3.6 million in construction for 340 TLQs was received from the Air Force Welfare Fund. The program was immediately popular with the major commands. The Welfare Board approved an additional 680 units on December 21, 1970. Thus, a total of 1,020 TLQs costing $10.73 million were planned for construction at 24 installations.[380]

Contracts for the Air Force's first TLQs were awarded in early 1972. Norton AFB, California, was the first base to break ground for TLQ construction in 1972. The TLQs were industrialized, relocatable structures, procured under the two-step procurement process. The FY72 program secured 760 units and 38 service buildings that were acquired from a single contractor and located at 18 bases in the south, west, and northern tier.[381] The TLQ program afforded Air Force personnel inexpensive temporary living quarters with modern appliances and conveniences. Design standards were devised to accommodate a family of five and to provide access to the Air Force base. Individual TLQs were relocatable, 360-square foot, modular units containing "an individual AC/Heating unit, wall-to-wall carpeting, [with] a living/sleeping area, a compartmentalized bath, and a kitchenette with range, refrigerator and sink with garbage disposer."[382]

CONUS-Special Projects

Design of the Aeropropulsion Systems Test Facility at the Arnold Engineering Development Center

Established immediately following World War II, the Arnold Engineering Development Center (AEDC) near Tullahoma, Tennessee, was among the most advanced aeronautics and aerospace research test facilities in the world. AEDC and major wind tunnel projects were constructed through the National Advisory Committee for Aeronautics (NACA), the predecessor of the National Aeronautics and Space Administration (NASA). NACA Research Centers were authorized by Congress through Public Law 81-415, the Unitary Wind Tunnel Plan Act of 1949 and the Air Engineering Development Center Act of 1949.[383] From the beginning, responsibility for the development and construction of the AEDC was assigned to the Arnold Engineering Development Division and the engineers assigned to that division.[384] AEDC also operated satellite research centers at installations at White Oak in Silver Spring, Maryland, and Moffett Field in Mountain View, California. AEDC test capabilities included the ability to simulate speed, temperature, and pressure. Many of the more than 58 test facilities at AEDC were unique to the United States; many were unique in the world. AEDC test facilities included propulsion wind tunnels, rocket and turbine engine test cells, space environmental chambers, arc heaters, and ballistic ranges. In concert with the Hypervelocity Wind Tunnel 9 at White Oak, Maryland, and the National Full-Scale Aerodynamics Complex in California, the AEDC simulated flight conditions from subsonic to Mach 20, and sea level to over 300 miles. The test center was valued at $7.8 billion.[385]

One of the most ambitious projects ever undertaken at AEDC was the construction of the Aeropropulsion Systems Test Facility (ASTF), a sophisticated wind tunnel complex designed to test advanced turbofan and turbojet aircraft propulsion systems in true mission environments in an earth-based research facility. The need for such a facility was identified in the late 1960s during the development of the C-5 aircraft and missiles. No facility existed for testing either the aircraft or missile engines. The Air Force was designated as the design agent for the new test facility in 1972. The responsibility for design management was assigned to the Civil Engineering Directorate at AEDC. A seven-person management team was organized within the Civil Engineering Directorate at AEDC; this team comprised technical experts representing the engineering specialties involved in the project. Initial oversight was provided by civil engineers at the Air Force Systems Command (AFSC) and towards the end of the project by a senior level review group created by Maj. Gen. Clifton D. Wright, Jr. at the Air Staff and discussed in the following chapter.[386]

The architect-engineer firm for the project was selected in April 1972, and a contract was awarded to the joint venture of Norman Engineering Company/Daniel, Mann, Johnson and Mendenhall (DMJM) in November of that year. The project design phase was long and complex; it extended from 1972 to 1976. Phases I and II (40 percent) of the design were completed by October 1974 at a cost of $5,470,319. Phase III of the design process occurred in 1974 and 1975 and completed 70 percent of the design for an additional cost of $3,947,819. The final phase of design, Phase IV, was executed between 1976 and early 1977 for an additional cost of $3,390,784.[387]

The ASTF design included two test cells each measuring 28 feet in diameter and 85 feet long that were capable of simulating altitudes of 100,000 feet above sea level and speeds of Mach 3.8 for engines generating 100,000 pounds of thrust. These test conditions were achieved through a bank of Swiss-made compressors that had a capacity of 1,500 pounds of air per second, and the largest bank of heaters in the world that could generate one billion BTUs per hour, thus raising the inlet airflow temperature to 1,020 degrees Fahrenheit. The heated exhaust was first cooled with a water spray, then passed through a 4,600–pipe heat exchanger, which reduced the temperature to 350 degrees. A second water spray lowered the exhaust to 120 degrees. Cooling water was re-circulated through a 3 million gallon closed loop reservoir.[388] Construction of the new facility began in 1977.[389] The ultimate cost for design and construction of the ASTF was $437 million.[390]

Cheyenne Mountain

Cheyenne Mountain, the underground Command and Control Center for the North American Air Defense Command (NORAD) formalized in 1958, was built to replace the earlier above ground center at Ent AFB, Colorado. Plans for this nuclear-blast proof communications center were initiated in 1956. The Air Force was the planner and general manager for the project and was charged with the coordination of numerous agencies and divisions. The U.S. Army Corps of Engineers was the design and construction agent for the project; the architect-engineer firm Parsons, Brinkerhoff, Quade & Douglas was the successful bidder for design and construction.[391]

Maj. Gen. Augustus M. Minton was personally involved in the site selection process.[392] Cheyenne Mountain near Colorado Springs, Colorado was chosen after the consideration of several potential sites; factors that favorably contributed to its selection included the area's sparse population, well-established electrical and communications system, and the mountain's solid granite geology. The Soviet launch of Sputnik in 1957 heightened Cold War tensions. As a result, planning and design for the Command and Control Center assumed what amounted to a wartime priority. The first dynamite blast for the $3.5 million excavation project was detonated on May 25, 1961. As excavation progressed, rock surfaces were stabilized with a variety of rock bolts, chain link, and steel fabric. Excavation proceeded quickly, but workers discovered a problem in January 1962 at the intersection of Chamber B and Chamber 2, the B-2 intersection. Two shear rock faces were discovered in the ceiling of the intersection. While the formations were stable under static conditions, there was no way to determine if the roof could sustain a nuclear blast. A specially engineered concrete dome was constructed to add additional structural support to this area.[393] Problems encountered during construction where frequently resolved expeditiously in the field by the Director of Civil Engineering, the AFRCE, and other project principals.

Construction inside one of the chambers of the NORAD Cheyenne Mountain Complex.

Construction of the complex buildings began in 1963 and included 15 independent structures covering 200,000 square feet; 11 buildings were three-stories tall. The buildings were constructed primarily of steel plate; the structures were supported by 1,300 springs made from 3-inch thick steel. Each spring weighed 1,000 pounds. This base isolator design enabled the buildings to "float," thus negating potential damage from shock waves generated during an attack. General Minton spoke proudly of the role that the Air Force civil engineers played in developing the "spring" design. He had sent a group of professionals to Europe to investigate missiles and to consult with a board of civil engineering advisors. The spring solution was an idea developed by this group. Tests were conducted at AFWL and the solution was found viable.[394] Additional shock absorbers were installed between the exterior walls of the buildings and the mountain rock to control sway. Emergency power was provided by six, 1750 KW generators capable of operating a full 30 days. The underground complex also included 1.5 million gallon domestic water reservoirs and a 4.5 million gallon non-potable water supply for cooling power plants and air conditioning. Heat generated by the computer equipment within the operations building was sufficient to heat the entire complex. In the event of an airstrike, two sets of 30 ton blast doors set 50 feet apart sealed the complex; the first set of doors was designed to reflect the majority of the blast down the south tunnel. In addition to the operations building, the complex contained a medical facility, pharmacy, dining hall, dental hall, and housing and support facilities to sustain 800 people for 30 days.[395]

The center at Cheyenne Mountain was completed on February 6, 1966 and occupied in April 1966 when the operations center moved from Ent AFB. The underground center was constructed for a total cost of $142 million.[396] Missions undertaken at Cheyenne Mountain included assisting in the April 1981 launch of the first Space Shuttle. The six centers at Cheyenne Mountain in the 1990s included the Command Center, Air Defense Operations, Missile Warning Center, Space Control Center, Combined Intelligence Watch Center, and Systems Center. In addition, NORAD continued to ensure air sovereignty of the United States and Canada, while the Air Force Space Command monitored all space objects. The Air Force Space Command assumed increasing responsibility for early-warning of short range ballistic missiles, such as Iraqi SCUDS.[397] In 1992, the mountain housed staff of NORAD, U.S. Space Command, Air Force Space Command, Air Weather Service, and Federal Emergency Management personnel. More than a thousand civilian and military personnel from the Army, Navy, Air Force, Marine Corps, the Canadian Armed Forces, and defense contractors worked in Cheyenne Mountain.[398]

Construction of U.S. Air Force Museum

Air Force civil engineers also were involved in the construction the U.S. Air Force Museum at Wright-Patterson AFB, near Dayton, Ohio. Home to the Wright Brothers and the site of early aviation experiments at Huffman Field, the Dayton area was known popularly as the birthplace of aviation. These historical associations and its geographic location within 400 miles of one-third of the U.S. population made Dayton an ideal candidate for a major museum. Additionally, the technical and engineering expertise of Wright-Patterson AFB personnel presented a unique asset to museum staff on the maintenance and appropriate display of aircraft. The initial Air Force exhibits were static displays in an open-air setting. As the collection of aeronautically significant material grew, a new enclosed venue was needed. Rare and valuable exhibits could not be displayed in the open, and seemingly durable aircraft eventually deteriorated with continuous outdoor exposure. An even more pressing problem was increasing museum visitation: attendance swelled from 10,000 in 1954 to 650,000 in 1969.[399]

In 1956, the Chief of Staff of the Air Force initiated the Air Force Museum Project, and tasked Headquarters Air Force Logistics Command (AFLC) with design, construction, and funding the project. Unfortunately, neither appropriated nor non-appropriated funds were available. The Air Force Museum Foundation, Inc. was created in 1960 to develop an alternative funding stream. The group, comprising local businessmen, raised $6 million to construct the museum. Maj. Gen. Billie J. McGarvey, then

U.S. Air Force Museum, Wright-Patterson AFB, Ohio.

AFLC Civil Engineer, served as the chairman of the Air Force Museum Planning Commission, which was established to monitor the architectural design and construction of the museum. The design program employed a pre-engineered building that maximized exhibit space and presented the potential for expansion. The Museum Planning Commission adopted a turnkey approach for project procurement; a single contractor would provide all services within a fixed price. A critical path method was adopted for the construction schedule. On March 4, 1970, the contract was awarded to Pascoe Steel Corporation.[400]

The new Museum was ideal for the exhibit and interpretation of Air Force equipment and aircraft. Measuring 765 feet long and 240 feet wide, it provided over 160,000 square feet of exhibit space surrounding a central 25,350 square foot core that housed offices, a theater, gift shop, records storage and archives, and a café. The building's modular construction allowed for flexible clear spans that could be reconfigured as needed. The arched space varied from a height of 32 feet at the side wall to 80 feet at the apex, which made possible the display of many of the largest aircraft, such as the massive B-36 *Peacemaker*. Smaller planes could be suspended from the open roof structure above the museum floor. The new museum building opened in 1971.[401]

The museum was expanded several times. The original 550-seat theater in the central service core was augmented by a new IMAX theater in 1991. Construction of the IMAX theater made possible the creation of a new glass-enclosed entry vestibule. A nearly identical building to the original museum, lacking only the central service area, was constructed in the 1980s to house aircraft from the Cold War and the Korean and Vietnam conflicts. Another expansion, dedicated in 2003, comprised a third barrel-roofed building to house additional Cold War aircraft and the Modern Flight Gallery. In 2004, a cylindrical building representing a silo opened to house the missile/space gallery. Efforts to acquire a Space Shuttle launched another drive to fund the construction of another display area. By 2010, the museum had over 1,000,000 square feet of exhibit space and a visitation of 1.2 million annually.[402]

Overseas Construction at Permanent Bases

Collocated Operating Bases (COBs)

International political changes during the 1950s and 1960s affected U.S. Air Force military bases in the European theater. NATO's defense strategy relied upon the ability to launch heavy strike retaliations from permanent main operating bases (MOBs). USAFE had primary responsibilities within this strategy. However, NATO was forced to modify this defense strategy due to MOB construction costs and the European domestic policies of the era. Several European countries passed legislation prohibiting permanent bases occupied by foreign militaries within their boundaries. Norway and Denmark refused to approve the construction of foreign military bases in 1954. In 1966, France ordered the removal of all U.S. Air Force personnel and materiel from within its national borders by spring 1967.

NATO altered its defense strategy and on October 31, 1966 the U.S. Air Force Basing Study was completed. The basing study introduced a new concept of joint-use bases known as collocated operating bases (COB). COBs were developed in Europe to meet increased beddown requirements to support contingency operations. Each COB was designed to provide Minimum Essential Facilities (MEF), which included personnel support from the war materiel reserve, a runway, ample aircraft parking, and storage for POL and ammunition to support one squadron. The COBs were minimalist installations where operations could begin as support personnel and facilities were augmented. COBs typically saved money in maintenance and repair. Another advantage of the COBs was the ability to disperse potential targets for enemy attack. Main operating bases presented attractive enemy targets; smaller COBs dispersed over a wide area were less likely to be primary targets and remain operational. The COBs were constructed beginning in the early 1970s.[406]

TABVEE Program

The hardened protective aircraft shelter program, known as TABVEE, was a major overseas construction program. The U.S. Air Force initiated a study on passive defensive protective measure as early as 1962. Between 1964 and 1965, the Air Force conducted a TABVEE study at Bitburg, West Germany. The results of this study entitled *Theater Air Base Vulnerability Estimate and Evaluation* (TABVEE) "revealed that dispersal and aircraft sheltering provide the greatest probability of survival when 'conventional' weapons are employed."[407] The study reviewed the criteria for base survival and recovery after an enemy attack. It was clear that an enemy offensive potentially would target airfields to disrupt operations. The lessons learned from the June 1967 Arab-Israeli Six-Day War illustrated the vulnerability of air bases, the inadequacy of prior base recovery tactics and materials, and the inability to retaliate after an air base attack. The Israeli Air Force nearly wiped out the entire Egyptian Air Force on the ground.

Additional studies on shelters to protect tactical aircraft from conventional weapons were undertaken by the U.S. military. Project 1597 evaluated several designs for aircraft shelters in 1966 through the Air Force Weapons Laboratory (AFWL) at Kirtland AFB, New Mexico. One main design criterion for such shelters was ease of construction in any environment. Air Force personnel tested several designs and materials, including arched roofs, flat decks, pitched roofs, space frames, various steel shapes and ballistic nylon blankets.[408] Eglin AFB's 560th CES (HR), a RED HORSE unit, assisted in evaluating the various aircraft shelters.[409] Even though comprehensive testing of the protective aircraft shelters was incomplete, four steel-arched shelters were purchased, shipped to Southeast Asia, and erected.[410]

In 1967, Project Concrete Sky partnered with Project 1597 to determine the appropriate volume of concrete to pour over the structures. Project Concrete Sky was an initiative directed by the Director of Civil Engineering to ensure that the shelters were easily produced by U.S. manufacturers to meet immediate needs in South Vietnam. Concrete Sky VIII was a test conducted in 1969 at Hill AFB, Utah.

Operation Fast Relocation (FRELOC)

In 1966, General Charles de Gaulle withdrew France from NATO. In a March 1966 letter to President Lyndon B. Johnson, General de Gaulle stated that,

> "France intends to recover in her territory the full exercise of her sovereignty, now impaired by the permanent presence of allied military elements or by the habitual use being made of its airspace."[403]

The United States was given an April 1, 1967 deadline to remove its forces from France, which prompted Operation FRELOC. The task of removing all forces and associated resources was overwhelming. It included: transferring 70,000 personnel, including NATO headquarters located in Paris; transporting or scrapping 80,000 short tons of equipment and provisions; and, emptying 190 bases. In addition, the United States had to establish new storage locations elsewhere. The U.S. Air Force lost nine bases, a depot, and other ancillary bases. Its total loss of real estate included 77 sites. On-going projects in France for the U.S. Air Force worth $638,000 and new projects estimated to cost $1,250,000 were halted.[404]

Three Prime BEEF teams with 42 personnel aided the USAFE Civilian Service Unit (CSU) in the removal of buildings and equipment. Work completed by these elements included transferring transformers, compressors, generators and buildings that could be dismantled. A large portion of the installed equipment went to other USAFE units. The buildings included small Quonset huts, but also large aircraft hangars. These salvaged buildings, for the most part, were shipped to a storage yard at Ramstein Air Base, West Germany, and were subsequently used by the CSU to erect buildings throughout USAFE including the command post, entrance canopy, and connecting passage-way in support of the relocation of USAFE Headquarters from Wiesbaden to Ramstein in the early 1970s. More than 1400 house trailers were relocated throughout Europe. By the deadline set by General de Gaulle, civil engineers had dismantled and transferred 240 buildings with a total square footage of 800,000. They also relocated 1,400 trailers, transferring them to West Germany, Turkey, and England.[405]

General Goddard tasked the CEC to select, lay out the site, and construct three shelters and revetments. The CEC deployed its site selection team to survey and select the site. Due to the compressed time frame for the test, military personnel completed the prep work. An 81-personnel Prime BEEF team was deployed to complete site grading, lay foundations, and construct the shelters. The shelters were in place for the scheduled June test.[411] Other tests conducted under Project Concrete Sky included the evaluation of three types of front access enclosures: steel, aluminum, and ballistic nylon.[412] Ballistic nylon curtains were installed on shelters in Vietnam and South Korea beginning in 1969.[413]

Eventually the U.S. Air Force selected a protective shelter and issued a design standard for a double corrugated steel arch with a 48-foot clear span. The structure was constructed of panels 2-foot wide by 6- to 13-foot long, bolted together to form an arch with a 24-foot radius; the structure weighed slightly less than one ton. The shelters were manufactured to fit inside existing 52-foot wide earth-filled steel revetments in Vietnam and were covered with either 4 feet of earth or 18 inches of concrete.[414]

By the end of 1968, manufacturers were producing an average of 35 shelters per week for shipment to South Vietnam, Korea, and Europe. The steel shelters were fabricated by three U.S. manufacturers: Marwais and Pascoe Steel Companies of California and Young Metal Products Company of East Chicago, Indiana.[415] The first operational hardened shelter was erected by the 823d CES (HR) at Bien Hoa on November 4, 1968. By the end of 1969, 300 shelters were erected in South Vietnam, 100 in South Korea, and construction was underway in Europe. Eventually, more than 400 of the double corrugated steel arch shelters were constructed in Vietnam. The majority of aircraft shelter construction in South Vietnam was completed by RED HORSE squadrons.[416]

Several modifications to the original TABVEE design occurred over time. The first TABVEE shelters typically were open, but could be enclosed through the installation of front and rear panels. Open shelters typically measured 70 feet in length, while enclosed shelters measured 100 feet in length. The mounted door on the first generation TABVEE shelters employed a hinged steel "clam shell" unit that was recessed 25 inches beneath the shelter arch. The second generation TABVEE shelters were 124 long by 81¾ feet wide and the closure was a rolling framed-steel door. This latter type was designed for the FB-111 aircraft at RAF Upper Heyford in England. The prototype for an armored metal closure was successfully developed and constructed at Ramstein AB, West Germany, in November 1970. The design of the shelters was modified again after 1972 to accommodate the new F-15 aircraft. A third generation shelter that could accommodate two F-15 aircraft came along in 1974. It had externally mounted steel-frame doors mounted on electrically driven rollers.[417]

By 1969, the TABVEE program was initiated on NATO bases. By the end of that year, $66 million had been authorized from the MCP to construct 342 TABVEE shelters. Construction of TABVEE shelters began at four central European air bases. By mid-1970, TABVEE shelters were erected at air bases at Aviano (30), Italy; Bitburg (72), Erding (18), Hahn (66), Ramstein (78), Spangdahlem (48), and Zweibrucken (42), West Germany; Soesterberg (18), Netherlands; and Incirlik (42), Turkey. Overall, 414 TABVEE shelters were slated for installation in Europe. These shelters were retrofitted with the armored metal front closures. In addition to the TABVEE shelters, the project also included the installation of associated dispersal pavements. Between August and November 1969, dispersal pavements were installed at Aviano AB, Italy; and Bitburg, Hahn, and Ramstein ABs in West Germany.[418]

Deployment of F-15 aircraft to Europe required the modification of many TABVEE shelters. Approximately 80 percent of the TABVEE construction program was completed in Germany and the Netherlands and 25 percent was completed in Italy and Turkey when designs for the F-15 were finalized. The U.S. Air Force continued the shelter construction program with the intention of altering a limited number of shelters to accommodate the F-15, as needed. These modifications included removal of the recessed front closure doors and supporting bulkhead; construction of a flush front-mounted closure system; and, installation of a tracking system to preclude aircraft damage due to close clearances.[419] Third-generation TABVEE shelters were programmed for construction in Europe during the mid and late 1970s.

Studies for a second stage of the TABVEE program began at USAFE in 1971. The scope included plans to harden aircraft support facilities, including squadron operations, ready crew facilities, LOX plants, refueling truck shelters, combat ops centers, and communications facilities. Additional passive defensive measures that were adopted during the late 1970s evolved from Project CREEK PROTECT. These measures included installation of exterior revetments and improved camouflage techniques.[420] Improved bomb damage repair capabilities were also included.[421]

Ice Way Runways at Thule

A unique construction project undertaken during the period was experimentation with ice runways. During the first six months of 1961, the Air Force Terrestrial Sciences Laboratory and the U.S. Naval Civil Engineer Laboratory conducted Project ICE WAY outside Thule AB, Greenland. Thule AB was one of three locations for ballistic missile early warning systems. Project ICE WAY objectives were to:

- Investigate certain physical and mechanical properties of natural, processed, and artificial sea ice;
- Test the operational utility of sea ice platforms under static and dynamic loadings;
- Study the effects of aging and ablation on sea ice structures;
- Evaluate the operational capability of sea ice construction techniques and of the materials and equipment used.[422]

Massive construction was required to complete the 14,000-foot runway, three parking pads, and a test plot. Each parking pad employed different materials and construction techniques. The first pad was flooded with seawater in incremental layers to achieve a total thickness of eight feet; the second pad was reinforced with fiberglass mats to create a thickness of six feet; and the third pad was constructed with ice aggregate, sea water and fiberglass mat to a thickness of five feet. Runway tests were successful; pilots reported that the ice runway was smooth and braking action superior to the regular Thule runway.[423]

EDUCATION AND TRAINING

General Minton and succeeding Directors of Civil Engineering strongly emphasized educational programs for Air Force personnel. By 1963, the Professional Education Program, Education-with-Industry Program, and Special Short Course Program were established. The first two programs were restricted to Air Force civil engineer officers. Extension courses also were available at Ft. Belvoir in Virginia. These courses were administered by the Army Engineer School, and prepared Air Force civil engineers for Engineer-In-Training and Professional Engineer (PE) exams.[424]

By 1965, 4,600 of the 90,000 personnel in Air Force civil engineering were officers and civilians in professional careers. Forty-five percent of the work force comprised registered PEs or those preparing to become registered engineers. In the 1960s the Air Force eliminated dead-end career paths and matched the personnel skills with U.S. and overseas assignments.[425]

Air Force Institute of Technology (AFIT)

The Air Installations Engineering Special Staff Officer School was renamed the Air Force Institute of Technology (AFIT) Civil Engineering Center in 1960. In 1968, the AFIT Civil Engineering Center again was renamed and became the AFIT Civil Engineering School. In 1969, AFIT celebrated its 50th Anniversary as an Air Force educational institution. The school traced its roots to the Air Service School of Application, which was established in 1919. In spring 1969, 515 resident graduate students were enrolled at AFIT and 3,883 additional students were enrolled in courses at civilian institutions. By 1969, AFIT had educated more than 8,900 Air Force civil engineers through the Civil Engineering School short course program.[426]

Operation Cool School

Operation Cool School, later known as Project North Star, began in 1959 and was sponsored by AFIT. The educational program was created to expose distinguished professors, engineers, and scientists to the complex activities surrounding the construction and operation of the early warning radar systems in Alaska, Canada, and Greenland. A 1961 Air Force Civil Engineering article described the school:[427]

> The classroom is a roving C-54 aircraft; the curriculum coverage extends from Greenland across the Arctic to Alaska; the faculty consists of senior military engineers and Arctic experts; and the students are distinguished university presidents and engineering educators. Everyone is graduated cum laude, of course.[428]

Maj. Gen. Augustus M. Minton, Director of Civil Engineering, was the host of the school. General Minton credited the idea of the school to Col. C. A. “Bud” Eckert, who ran the

continued

Operation Cool School *continued*
engineering school at Wright-Patterson. Colonel Eckert wanted to showcase civil engineering efforts to educators.[429] The annual trips were not merely a tour, but a rigorous and often dangerous exercise. Aircraft equipped with skis were used to land on glaciers that surrounded the sites and temperatures sometimes dropped to 40 degrees below zero.[430]

The goal of the school was larger than merely an educational opportunity. General Minton's intentions included publicizing the work of Air Force civil engineers, and also illustrating that Air Force engineers should be considered professionals in their field. Dr. Lawrence Kimpton, Chancellor of the University of Chicago remarked after his experience with Cool School, "I ended up with an enormous respect for the AF and for the job that is being done in the Arctic for the protection of the country."[431]

In a 2001 interview, General Minton stated "We didn't ask people. We'd get applications saying, 'I'd like to be considered for your next trip.' We built that up and got a good reputation among the professional people."[432]

Operation Cool School ran five expeditions, ending in 1962. Approximately 40 guests were involved in the experience, including professors, deans, and university presidents from Massachusetts Institute of Technology, Stanford, Pennsylvania State, and other universities across the country. A primary benefit that resulted from Cool School was a greater appreciation and comprehension of the challenges confronted by Air Force engineers. The program allowed leading members of the academic community to form connections with the Air Force civil engineers, and acknowledge them as associates within the population of professional engineers. The Project North Star trips continued later in the 1960s with then-Col. John Peters and Mr. Harry Rietman leading trips until they ended in 1969.[433]

Beginning in 1964, AFIT offered a nine-week course called Applied Engineering. This course was developed as a result of a 1963 study that showed as of March 31, 1962, only 303 of 2,386 Air Force civil engineering officers held electrical or mechanical engineering degrees. Of those 303 officers, more than half had established their date of separation from the Air Force. A subsequent study showed that the 303 number had decreased to 163 by 1964. Clearly, a need for additional education in the electrical and mechanical fields was evident. The Applied Engineering course was developed to cover heating and air conditioning; electrical circuits, distribution and controls; corrosion control; engineering economics; and data processing. The first six weeks were dedicated to the theory of mechanical and electrical engineering while the students spent the final three weeks applying the theory on a typical field problem. Although the students found the course beneficial, the class quotas were hard to fill because of the course's length. It struggled along until it was discontinued in 1974 and replaced by shorter air conditioning courses as the number of electrical and mechanical engineers increased.[434]

In 1962, the Training-With-Industry program was authorized to begin in FY63. The program, which eventually was renamed Education-With-Industry (EWI), was managed by the Civilian Institutions Division of AFIT. The objective of the program was to expose Air Force civil engineers to the methods and procedures employed in the civilian industrial sector with special emphasis placed on management.[435] The program was tailored to officers pursuing careers in Base Civil Engineering and included the following educational tracts: Civil Engineer Management, Astronautics and Space Vehicle Facilities, Civil Engineer Industrial Maintenance, Civil Engineer Design, and Civil Engineer Heavy Construction. Requirements for acceptance into the program varied with curriculum tract: Astronautics and Space Vehicle Facilities was open to officers holding ranks of major or lieutenant colonel; Industrial Maintenance was open to officers holding the ranks of captain through lieutenant colonel; and, Design and Heavy Construction were open to officers holding the ranks of captain through lieutenant colonel. Although candidates who had completed a previous graduate degree were preferred, officers possessing a Bachelor of Science degree in engineering or science were also accepted. Successful candidates had 10 months to complete the program. [436]

In 1964, the EWI program partnered with United States Steel and International Business Machines (IBM) to provide officers with opportunities for immersion in high profile automated industrial companies. IBM offered a particularly relevant training opportunity through their USAF and NASA related Space Guidance Center (SGC). Officers worked with advanced guidance systems and computers that provided support for satellites, missiles, and navigational systems. Working in the SGC exposed Air Force civil engineers to all facets of the company and provided an appreciation for the integration of operations within the overall company. The challenges of integrated operations in the private sector were comparable to many of the challenges met by a base civil engineer. Through the EWI partnership program, officers experienced private sector business methodologies and practices developed to meet a competitive market. These methodologies and practices were directly applicable to many of the operational responsibilities assumed by a base civil engineer. Through their work with leading companies in private industry, Air Force civil engineer officers gained practical experience in effective and efficient business practices.[437]

The EWI program was an ideal alternative for officers who did not qualify for, or choose to pursue, graduate school. The program offered opportunities for educational advancement and pragmatic experience. This approach also appealed to officers who already had completed a graduate degree.[438] A student who participated in the Civil Engineer Industrial Maintenance EWI program reflected on the scope of the program,

> My EWI program at General Electric-Evendale, (Ohio) has been a most interesting experience. During the 10 months of the program, I have been exposed to the various aspects which make up the complex business of maintaining a large industrial facility…. I have run the gamut from one end of the organization to the other, and in the process have been exposed to management decisions, maintenance practices, planning procedures, material handling methods, utility operations, company and union policies, grievance procedures, administrative practices and many other experiences too numerous to mention…. The personal development I have realized during this training period should prove of immeasurable value to me and the United States Air Force in the coming years.[439]

Many participants with the EWI program praised its benefits and expressed appreciation for the pragmatic experience that could not be replicated in a classroom environment.[440]

The Special Short Course Program on advancements in technology was offered by the Civil Engineer Center at AFIT. Courses offered in 1963 included base civil engineering, executive engineering, pavements, and management, as well as nuclear defense planning, and requirements for missile and space facilities. The purpose of the program was to provide focused courses in the latest technologies and Air Force procedures. As a result, the subjects offered varied from year to year. Short courses ranged from one to nine weeks. Admission to selected courses required letters of recommendation from AFIT. While enrollment for some courses was selective, other courses were open to all applicants and filled on a first come, first served basis.[441]

The Professional Education Program, also offered by AFIT, offered courses to Air Force civil engineer officers in architecture, architectural engineering, civil engineering, electrical engineering, environic engineering, industrial engineering, mechanical engineering, nuclear engineering, space facilities engineering, and engineering management. The program was designed to benefit officers holding baccalaureate degrees outside the field of engineering who met the military and academic prerequisites for enrollment in the program. These prerequisites included completion of at least 30 credit hours of coursework that could be transferred and applied towards a degree in engineering and a minimum grade point average (GPA) of 2.0. Those wishing to pursue graduate work towards a M.A. degree were required to hold a professional degree in engineering or a degree from a service academy; a GPA above 2.0 also was required. The Ph.D. program required a master's degree in a related field and a minimum GPA of 3.0.[442]

In 1971, the Air Force Educational Requirement Board's Civil Engineer Panel proposed the development of a master's degree in management and/or administration for civil engineers. A large number of civil engineers held positions that required personnel and financial management skills. An advanced degree in management and/or administration paired with an undergraduate degree in engineering provided an ideal educational background for civil engineering officers. Initially, AFIT coordinated the program through civilian institutions. The majority of graduate business schools offered an 18-month curriculum geared primarily toward civilian industrial management and administration. Air Force civil engineers enrolled in such programs were forced to extrapolate their education to military application in the Air Force. To overcome this obstacle, the AFIT School of Systems and Logistics created the Graduate Facilities Management Program. The program included 12 months of study and was administered at Wright-Patterson AFB in Ohio. The faculty included 23 officers and 4 civilians, ninety percent of whom held or were working towards their PhD. Requirements for enrollment in the program were three years of civil engineering experience, an undergraduate degree with a GPA of 2.5 from an accredited educational facility, and a minimum Graduate Record Exam score.[443]

In the early 1970s, Brig. Gen. Archie Mayes, then Deputy Chief of Staff for Civil Engineering at SAC, suggested to Col. Al Nemetz, the AFIT dean, that he establish a traveling team to teach courses at various bases. Colonel Nemetz sent a team of instructors to San Antonio to teach a one-week condensed version of the BCE course. The experiment was a success and AFIT began its Civil Engineering Management Applications Regional Seminar (CEMARS) program. Maj. William R. Sims led the first class and got the program off to a successful start. CEMARS courses were soon taught at bases around the world. The team traveled to Ramstein in 1978 and Okinawa and the Philippines in 1985.[444]

U.S. Air Force Academy

In 1964, a civil engineering major was introduced at the U.S. Air Force Academy. Required classes for the major were surveying, soils mechanics, hydraulics, air base engineering, construction engineering, and a course in water supply and waste disposal. In addition, students chose two of the following courses: foundation engineering, pavement design, structural engineering, civil engineering design, independent study or materials science. Overall requirements for the civil engineering major included 45.5 hours of core science and engineering courses, 53.5 hours of core social science and humanities courses, and 47 hours of major courses specifically required for civil engineer students. The core curriculum included basics such as English, calculus, foreign languages, history, physics, chemistry, and engineering fundamentals. Coursework more specific to Air Force engineering activities included physiology, computer science, astronautics, aeronautics, electronics, law, psychology, human relations, economics, and international relations. These courses made up approximately two-thirds of the educational curriculum at the academy.[445]

Academy instructors were required to hold a master's degrees; one quarter of the faculty held PhDs. In addition to their educational backgrounds, instructors also were required to have "several years of practical experience in the military." Faculty members were not only instructors, but also mentors providing guidance and inspiration to encourage and advocate for careers in the Air Force. In 1966, the first 50 students majoring in Civil Engineering were graduated. Shortly after the creation of the major, the Loeschner Award for Outstanding Cadet in Civil Engineering was established. The award was named after Maj. Theodore R. Loeschner, a former USAFA Civil Engineering faculty member, killed during the Vietnam War.[446]

Department of Civil Engineering Training, Sheppard Air Force Base, Texas

By 1963, the Department of Civil Engineering Training at Sheppard Air Force Base had grown tremendously. The department maintained an inventory of equipment estimated at $13 million and employed approximately 450 personnel, including instructors, managers, and writers. According to Lt. Col. George Talbot, director of the department during the early 1960s, "this Department has one purpose: to produce high quality, technically trained non-commissioned officers, civilian technicians, and Airmen in the Facilities, Construction, and Utilities career fields."[447] The department included three training branches: Electrical Power Production, Refrigeration, and Building Trades. The Electrical Power Production Branch provided instruction in a wide variety of equipment, ranging from small gas powered apparatus to large diesel units. Training provided by the Refrigeration Branch covered air conditioning systems and multiple types of equipment controls. Instruction provided by this branch addressed systems from small household air conditioning units to 100-ton systems utilized by NORAD. The Building Trades Branch provided instruction in plumbing, missile facilities and sewage treatment systems. Each branch offered additional training opportunities in supervisory skills, inspections, maintenance, and a variety of supplementary topics.[448]

Between 1959 and 1964, the civil engineering training department at Sheppard AFB reached 3,000 students through resident courses. Traveling instructors taught additional courses at remote facilities to an additional 1,000 students. Courses included missile facilities, missile testing, refrigeration, electrical systems, and power production. These courses integrated on-the-job training and classroom instruction. Contractors, as well as military personnel, delivered the courses, which ranged in length from one week to nearly four months. Eventually, traveling teams of instructors provided supplemental training on new technologies to earlier graduates. This continuing education ensured that civil engineers were kept abreast on new technologies and developments in the field.[449]

A 1965 *Air Force Civil Engineer* magazine article titled "A New Breed…the CE Missile Officer" summarized the responsibilities of a civil engineer engaged in missile operations. The article profiled 28-year-old Capt. Robert W. Heller of the 390th Missile Maintenance Squadron at Davis-Monthan AFB in Arizona. Capt. Heller held a degree in mechanical engineering from the University of Colorado and previously served as a utilities engineer for the Semi-Automated Ground Environment system at Grand Forks AFB, North Dakota. Captain Heller acquired indispensable information and practical skills in missile operation during his training at Sheppard AFB. He completed a seven-week course in ballistic missile launching, officer training, and advanced courses. He became the officer-in-charge of Plant Maintenance for the Real Property Installed Equipment Branch of the 390th and was charged with the responsibility for two Titan II squadrons.[450]

Fire School

In 1960, the Fire School at Lowry AFB, Colorado was relocated to Greenville AFB, Mississippi. Greenville's fire school operated for four years and was plagued by problems. Similar to Lowry, instruction at Greenville AFB was held in an old hangar. Poor equipment maintenance hampered personnel training. Equipment was overused and the civilian firm charged with maintenance of the military crash trucks was inexperienced. By the time the Greenville fire school closed in 1964, two-thirds of the crash trucks recorded severe maintenance problems and were unusable. In July 1965, fire training was relocated to Chanute AFB, Illinois. The fire school, under the command of Chief Warrant Officer Louis F. Garland, incorporated several new courses in fire protection and sought to develop nationwide standards in firefighting.[451]

The Professional Degree Program

The University of Wisconsin established an innovative Professional Degree Program in 1970, which offered several advantages to Air Force civil engineers seeking to advance their education or expand their knowledge in particular areas. Entrance into the program required a bachelor's degree in engineering. The majority of classes were correspondence courses. The program's flexibility enabled civil engineers to maintain full-time assignments while taking courses. The curriculum included engineering and management, with an emphasis on recent technologies. The degree requirements included a minimum of 1,200 course hours. The hourly requirement was considered comparable to 25 semester credits. Coursework had to be completed within seven years.[452]

Base Civil Engineering In-House Training Program

In some cases, formal educational programs did not meet all training needs required to support base civil engineering. During the early 1970s, this shortcoming was acknowledged and addressed through an In-House Training Program. The main purpose of the program was to improve job performance at the base level and to enhance the capabilities of the base civil engineering organization. Teamwork, management, and technical proficiency were identified as areas providing opportunities for in-house training. Base civil engineers were responsible for designing programs specific to their needs and areas of responsibility. Instructors were chosen by the base civil engineer. The base civil engineer could also appoint a staff member to oversee the program, while retaining responsibility for selected aspects, such as participants and instructional topics. The base civil engineer's support was essential throughout the development and implementation of the program.[453]

Civilian Education

During the late 1960s, education also was promoted for civilian personnel working in the civil engineering career field. The Air Force employed nearly 3,500 civilians in professional employment categories within the Civil Engineering career field; these employees were designated with a specialty code equivalent to an officer. In many cases, civilian personnel represented a valued and experienced workforce, which lacked higher education. A 1967 assessment identified that 86 percent of civil engineer officers held bachelor's degrees while only 44 percent of their civilian counterparts possessed comparable levels of education. Civilians had many options and opportunities for advancing their education with the support of Air Force. They could attend courses at local universities or enroll in courses offered by AFIT. At AFIT, civilians could enroll a two-year resident course, or participate in short courses that spanned a few weeks.[454]

CIVIL ENGINEER WARTIME READINESS AND DEPLOYMENTS

Between 1960 and 1975, Air Force civil engineers engaged in a variety of deployments, both at home and abroad. During the early 1960s, Air Force civil engineers participated in two brief deployments: the Berlin Wall crisis (1961) and the Cuban missile crisis (1962). The longest contingency deployments were associated with Southeast Asia and the Vietnam Conflict (1961-1973) and the Korean peninsula (1968) following the seizure of the *USS Pueblo*.

Challenges were presented by each deployment. Civil Engineers consistently applied the lessons learned from earlier experiences to better anticipate and address the issues presented in the next deployment. Throughout the period, one major challenge focused on who was to establish air bases and how to establish them effectively in remote deployment areas. In 1964-1965, the Air Force civil engineers answered this challenge through the formation of Prime BEEF teams and RED HORSE squadrons.

During the period, Air Force civil engineers not only deployed to support contingencies, but also worked in emergency recovery situations in response to natural disasters in the United States and around the world. The requirements for these contrasting deployments necessitated the development of a meaningful training program to hone and expand appropriate skill sets.

Berlin Wall Crisis, 1961

Air Force civil engineers played a crucial role in the rapid U.S. military buildup in central Europe following the Soviet Union's construction of the Berlin Wall separating East and West Berlin in 1961. Construction of the wall was rooted in Soviet objections to West Germany's deepening alliance with the West through its membership in NATO. Tensions between the U.S.S.R. and NATO were heightened by threats from Soviet Premier Nikita Khrushchev. During summer 1961, tensions led to an increased number of East Germans fleeing to West Berlin. Khrushchev's demand for allied forces to leave Germany in June 1961 followed by his pledge to give control of Berlin to East Germany by the following January, prompted U.S. President John F. Kennedy to increase the number of U.S. Armed Forces in Europe and to request an additional $3 billion for defense spending. At 2:00 a.m. on August 13, East Germany installed barbed wire along the border between East and West Berlin; within a few days construction began on a permanent barrier that eventually included concrete walls and watchtowers manned by guards with guard dogs. Personnel monitoring the border between east and west were authorized to use deadly force, if necessary, to prevent movement across the wall.[455]

As part of the U.S. response, the U.S. Air Force began a two-phased deployment of aircraft under Operation Stair Step to reinforce USAFE in Europe should war develop over access to West Berlin. Under the first phase, TAC deployed the Tack Hammer Composite Air Strike Force to USAFE. The TAC deployment was an interim response until ANG units were mobilized and deployed to Europe. The first units of the strike force arrived in Europe on September 5, 1961. Mobilized ANG units arrived at French bases during October and November 1961. This was the largest overseas deployment of U.S. aircraft since World War II.

On August 16, 1961, Brig. Gen. Oran O. Price, deputy chief of staff, Civil Engineering for USAFE, and his organization were given 12 days to formulate a facility expansion program to accommodate the anticipated Air Force aircraft and personnel. The Facility Programs Panel, based at Headquarters, USAFE, immediately reviewed conditions at active, inactive and standby airfields in central Europe and developed recommendations for coordinated facilities. Implementation was estimated at several million dollars and received Air Force approval on September 1, 1961. The Air Force gave USAFE authority to proceed with maintenance and repair projects, to award FY62 construction projects germane to the buildup, to proceed with selected projects within specified dollar ceilings, and to purchase up to $500,000 in construction supplies. USAFE was authorized to designate the construction agent, which allowed greater flexibility to execute the construction program quickly.[456]

To prepare for incoming units, USAFE activated Civil Engineer Mobile Teams, a concept developed in USAFE following the Lebanon Crisis.[457] Civil engineering officers and non-commissioned officers were assigned to temporary duty to reactivate bases. The mobile teams were able to provide basic services for units arriving with little prior notice. In one instance, USAFE received one day notice prior to the arrival of units, and one unit was assigned to an inactive base. New operational facilities erected during the buildup were pre-engineered and prefabricated. These facilities included ammunition storage structures, alert shelters, maintenance hangars, and shops. Procurement of power generation equipment proved to be a challenge. Maintenance and construction projects were completed by the Air Force civil engineer organization, Army engineer troops, and private contractors, although, General Price described the Army engineer support as "something less than satisfactory." The one Army engineer battalion assigned to support the Air Force was neither trained nor equipped for airfield work and took six weeks before it was operating effectively. In addition, the Air Force had to provide housing, messing, supplies and equipment for the unit. Most of the air buildup forces were in place by early November 1961.[458]

Air Force engineers also participated in the implementation of Operation Bamboo Tree, the mission order by President Kennedy in fall 1961 to improve landing and navigation facilities at Tegel, Gatow, and Tempelhof airports in West Berlin, and at several other airfields in West Germany. The U.S. Army Construction Agency, Germany, oversaw construction as the agent of the Air Force.[459] By April and May 1962, the tensions over Berlin eased and the mobilized ANG units returned to the United States by the end of August 1962.

Some of the lessons learned by Air Force civil engineers during this crisis was the value of the Civil Engineering Mobile Teams and an appreciation for the time required to compile sufficient data on bases in the command, to secure the authority to get the job done, to prepare power generators and to construct pre-fabricated buildings. This buildup occurred in a developed area on some of the best standby bases in the world with access to contractor support and skilled labor. The high security nature of the operations also posed diplomatic challenges; U.S. activities were classified at Top Secret. General Price reflected,

> During this period, the United States elements possessed authority, money and guidance at their command but had no legal means of discussing this with host countries and allies in NATO. If you want to accumulate gray hair in a hurry, try building facilities on a crash basis on an airfield owned by one foreign country and operated by another without being able to tell either element what is going on.[460]

Cuban Missile Crisis, 1962

The threat of nuclear war became a reality for most Americans in October 1962. The Soviet Union began constructing medium-range missile sites in Cuba in August 1962. Launch pads at the missile sites could fire missiles with a range of 1,000 miles thus posing a grave threat to the United States. On October 14, 1962, an American spy plane photographed construction at the missile sites, confirming months of rumors. In a televised statement on October 22, 1962, President Kennedy alerted the American public about the presence of the missile sites and warned the Soviet Union that the United States would consider a "nuclear missile launched from Cuba against any nation in the Western Hemisphere as an attack by the Soviet Union on the United States."[461] Kennedy directed the Navy to intercept Soviet ships headed towards Cuba. The crisis was resolved on October 28, 1962 when the United States promised not to invade the island and Soviet Leader Nikita Khrushchev announced the missiles would be removed.

During the Cuban missile crisis, Maj. Gen. Augustus M. Minton, then the Director of Civil Engineering, was sent to Florida to monitor the situation closely. When asked what the Air Force civil engineers did to prepare for the crises, General Minton replied that the civil engineers' jobs were to:

> get ready to do the things that they were supposed to do, in case it did happen, and that was a myriad of things. Each one of those bases (in Florida) had its own little effort that they had to make, depending on circumstances. I think most of them practiced it, to a certain extent, but the crisis soon blew over. It just took one thing to blow it over, and that was a couple of big airplanes flying over, loaded and ready to go. There was a lot of bluff in that, but on the other hand, if they'd launched a few of those missiles at Miami it could have been very difficult for us.[462]

TAC civil engineers reopened the former Opalocka Naval Air Station (NAS) near Miami, Florida. The DoD chose this station as a staging base for U.S. strike forces in the event of war. One element of the base that required rehabilitation was the POL facility. TAC assembled a team of in-house personnel and equipment. Personnel arrived from several TAC bases and included 11 liquid fuels maintenance personnel and 4 electricians. The first members of the team arrived late in the evening on October 22, 1962. Team members were not informed of their assignment, but directed to bring tool kits and a week's worth of work clothes. Three and one-half days later, the POL system was operational.[463]

For then Lt. (later Maj. Gen.) Joseph A. Ahearn, the Cuban missile crisis was a defining career moment. Lieutenant Ahearn was stationed at Goose Bay AB in Labrador, Canada. The base mission was to keep the refueling tankers flying to supply the nuclear air force as they circled the north pole for three days. As General Ahearn described,

> Our job was to refuel the tankers that were refueling the bombers. The weather was awful. I drove a snowplow, with the big lights. They had whiteouts up there. During that whole mission it was snowing so bad you couldn't see. It was absolutely miraculous that we didn't lose an airplane. The tankers would have to go out and refuel [the bombers] and then come back. The base was actually closed [because of the snow], but we never closed it. The air traffic controllers would just talk the pilots down. We'd meet them about midway in the runway with our snowplows and guide them off. It was the damnedest teamwork you've ever seen in your entire life, but we didn't lose a single airplane. Why, I don't know. That particular experience connected me pretty deeply with the operational side…. I found airfield operations, particularly during high-stress periods, to really be a wonderful playing field. I really enjoyed it.[464]

Air Force civil engineer participation in this brief crisis illustrated the need for improved comprehensive coordination among civil engineering personnel. During the crisis, civil engineering teams were assembled at random and transported by aircraft traveling from base to base picking up available personnel. This was the first time that such a response was viewed "up-close" by CONUS civil engineer leaders and helped reinforce the need for change. The experiences of Air Force civil engineers during the Cuban missile crises, along with the growing number of deployments to Southeast Asia, was the impetus for General Curtin forming the Civil Engineering and Manpower and Organization Study Group in December 1963. The work of this group resulted in Project Prime BEEF, which implemented a civil engineering military capability worldwide.[465] Project Prime BEEF is discussed earlier in this chapter under Personnel.

Another consequence of the Cuban missile crisis was an increased awareness of the importance of contingency planning, specifically for activating bases effectively in remote or unprepared areas. TAC began a program to prepare deployment packages, code name "Gray Eagle." These packages included tents, vehicles, runway lighting, shelters, prepositioned consumables, and other support equipment.[466]

Dominican Republic Crisis, 1965-1966

The first deployment of a Prime BEEF team occurred on May 1, 1965 to San Isidro AB, Dominican Republic. The Dominican Republic was experiencing political unrest. In April, the country's liberal movement took to the streets to oust a non-elected conservative government. The revolution appeared to be evolving into a civil war as the conservative military forces struck against the government opposition with tanks and aircraft. On April 28, President Johnson committed U.S. troops to intervene in the civil strife. Ultimately 20,000 U.S. troops were sent to Santo Domingo in the Dominican Republic to restore order.[467]

The Prime BEEF team's mission was to assist the airlift fleet, which transported U.S. Army Forces to the Dominican Republic to support Operation Power Pack and evacuated U.S. and foreign nationals to safety. The first nine civil engineers deployed were from Myrtle Beach AFB, South Carolina; they

Table 3.2 First Prime BEEF deployment in May 1965

Career Field	No. of Personnel Deployed May 1, 1965	No. of Personnel Deployed to Augment Team
Maintenance Engineer	1	
Electrician	2	3
Electric Power Line Specialist	1	
Construction Equipment Operator	1	1
Carpentry Specialist	2	
Plumbing Specialist	1	
Water/waste Specialist	1	4
Electric Power Production Specialist		2
Pavement Maintenance Specialist		4
Refrigerator/Air Conditioner Specialist		1
Fire Protection Supervisor		2
Fire Protection Specialist		8
Total Personnel	9	25

Source: Capt R. J. Oelke, "Prime BEEF Goes to Santo Domingo," Air Force Civil Engineer, Vol 7, No 1, Feb 1966, 16.

were part of a combat support group (CSG) deployed with the TAC Air Forces, U.S. Atlantic Command. Personnel for the mission were selected based on their skill sets (Table 3.2). When activities in the Dominican Republic intensified, the initial team was augmented with an additional 25 persons. The Prime BEEF team established an expeditionary camp using Gray Eagle mobility support equipment and kept San Isidro AB operational.[468]

The majority of materials needed for the mission were flown to the area from CONUS. Equipment airlifted to the base included a runway lighting set, a fire crash truck, a pumper, and a portable water purification unit. Generators also were flown in to supply reliable power for Air Force operations and airfield lighting equipment. Water was piped to the air base from seven miles away, but was often compromised by nearby rebel fighting. In addition, the water was untreated. Lessons learned from the deployment included the desirability of lighter weight, standardized generators to simplify the procurement of spare parts. The experience also demonstrated the need for better shelters; the tents employed did not withstand storms and sometimes collapsed.[469]

Air Force support of the operations in the Dominican Republic continued into 1966. By February 1966, three additional Prime BEEF teams from TAC bases had deployed on 60-day rotations to San Isidro AB in the Dominican Republic.[470] In September 1966, the last U.S. forces left the country.

Vietnam Conflict, 1961-1973

Overview of Conflict, 1961-1968

Tensions between the United States and the Soviet Union and China intensified in Southeast Asia during the mid-1950s and early 1960s. U.S. commitment to an anti-Communist regime in Asia dated to the early 1950s when the United States supported the French colonial efforts in Indochina. The government of France had a long-term interest in the countries of Southeast Asia; Vietnam, Cambodia, and Laos were jointly referred to as French Indochina. During the 1950s, the French were engaged in a conflict with Communist forces loyal to North Vietnamese leader Ho Chi Minh. After a disastrous defeat at Dien Bien Phu in May 1954, the French withdrew from Vietnam.[471]

The timing of the Viet Minh victory at Dien Bien Phu aided Ho Chi Minh in the Geneva conferences held later in 1954. Attended by representatives of the French, American, British, Soviet, and Chinese governments, the conference was intended to resolve problems in both Korea and Vietnam. The conference did little to resolve any issues. The separation of North and South Korea continued; Vietnam was divided at the 17th parallel; both Cambodia and Laos were split from Indochina; and, the tensions created during decades of European control set the stage for further conflict. Ho Chi Minh established a Communist government in North Vietnam. Ngo Dinh Diem became the leader in South Vietnam. Elections in North and South Vietnam were scheduled to decide the fate of the country: continued division or unification. However, elections were never held. The Viet Cong, guerrilla soldiers remaining in South Vietnam after the 1954 Geneva conference, began harassing South Vietnamese authorities. The South Vietnamese government appealed to the United States for additional aid.[472]

U.S. policy sought to check Communist expansion into South Vietnam and to fill the vacuum created by the French withdrawal from the region. American policy makers sought to prevent the realization of the Domino Theory, a term coined in the 1950s to describe the potential fall of successive governments to communist control.[473] Consequently, the United States sent military and economic advisors to support South Vietnam.[474]

In December 1961, the United States increased the number of military advisors in South Vietnam to counter increased North Vietnamese guerilla activity there and in neighboring Laos. Between December 1960 and December 1962, U.S. military personnel stationed in Vietnam rose from 900 to 11,300.[475] Approximately one-third of these were Air Force personnel. The first permanent Air Force unit, comprising 67 officers and Airmen, was stationed in Tan Son Nhut AB near Saigon, South Vietnam, in September 1961. By November 1961, another Air Force detachment was stationed at Bien Hoa AB near Saigon to fly reconnaissance and combat missions, in addition to training South Vietnamese airmen. During 1962, Fairchild C-123 transport aircraft and additional personnel arrived.[476] By December 1962, 2,429 Air Force personnel were stationed in South Vietnam with an additional 1,212 Airmen located in Thailand. By December 1963, 4,630 Airmen were stationed in South Vietnam with an additional 1,086 Airmen based in Thailand.[477] The primary air bases in South Vietnam were Tan Son Nhut, Bien Hoa, and Da Nang; outlying airfields were located at Can Tho, Nha Trang, Soc Trang, Pleiku, and Qui Nhon.[478]

U.S. participation in the conflict in South Vietnam increased dramatically in 1964. In early August, it was reported that American destroyers had been fired upon in the Gulf of Tonkin on August 2 and 4. On August 7, the U.S. Congress passed the Gulf of Tonkin Resolution, which gave the U.S. President broad powers to commit U.S. troops in South Vietnam without prior consultation with Congress. Congress enabled President Lyndon B. Johnson to use "all necessary measures to repel any armed attack against American forces."[479] The U.S. military buildup after this incident was swift. Within days, additional aircraft were assigned to Tan Son Nhut, Da Nang, and Bien Hoa ABs. Other aircraft were positioned in Thailand, the Philippines, Okinawa, and Guam, to support an air war.[480] By December 1964, U.S. military personnel assigned to South Vietnam numbered 23,300.[481]

In February 1965, President Johnson authorized a bombing campaign against the North Vietnamese known as ROLLING THUNDER, a restricted gradual bombing campaign against North Vietnam's supply system. During 1965, the Air Force conducted 55,000 sorties; in 1966, the number of sorties doubled to 110,000.[482] In addition to conducting bombing raids and fighting enemy aircraft, Air Force personnel also conducted transport throughout the country, sprayed herbicides, and supported Army ground troops using conventional weapons, as requested. Jet aircraft were first stationed in South Vietnam in 1965. At this time, the original training mission was abandoned and the U.S. was a direct participant in the fighting.

By December 1965, 184,000 U.S. military personnel were stationed in South Vietnam; Air Force personnel numbered 20,620. By December 1966, U.S. military personnel numbered 485,587 of which 52,913 were Airmen. An additional 26,113 Airmen were stationed in Thailand.[483] The bombing campaign lasted until November 1, 1968 when President Johnson halted all bombing above the nineteenth

14th Civil Engineering Squadron Supply building at Nha Trang AB, South Vietnam.

parallel. By December 1968, Air Force personnel serving in South Vietnam numbered 58,434. The number of U.S. military personnel deployed to South Vietnam peaked at 542,400 in January 1969.[484]

Organization of Air Force Civil Engineers in South Vietnam

Air Force civil engineers were on the ground early during the ramp-up to support Air Force installations. During the early stages of U.S. involvement, Air Force units were joint tenants at 17 Vietnamese air bases and were not accompanied by civil engineering support staff. Soon, base civil engineer squadrons were staffed to supplement host country airfield operations. The typical base civil engineering organization at these bases comprised one civil engineering officer and a few enlisted personnel who were power production technicians and firemen. Day labor support was provided by local nationals. This staffing was sufficient to perform operations and maintenance, but not large enough to handle major construction projects.[485] Initially, base civil engineer squadrons were on temporary duty assignments drawn from PACAF.[486]

Additional civil engineers were needed and a program code-named TOP DOG was established. This program furnished experienced temporary duty personnel from CONUS until permanent unit manning requirements were established and permanent changes of station were activated. Through the TOP DOG program, personnel with the skill sets needed to provide base operation and support were sent to Southeast Asia. The TOP DOG program ended in November 1965.[487] Between August 1964 and August 1965, 800 civil engineer officers and Airmen completed temporary duty assignments in South Vietnam and 500 completed assignments in Thailand.[488] After 1965, civil engineers were rotated through on regular deployments, typically lasting a year. However, the base civil engineer squadrons were not manned fully until after the buildup of bases was completed.[489]

The buildup of U.S. military personnel and equipment drove a concurrent requirement for new construction. The U.S. Military Assistance Command, Vietnam (MACV), established in February 1962 in Saigon, reported to the Commander in Chief, Pacific (CINCPAC), and commanded the 2d Air Division. Stationed in Saigon, MACV initially served as the focal point for defining project requirements,

A sign in front of the base dispensary under construction at Binh Thuy spells out the hierarchy for building facilities in Vietnam.

but it did not have a large engineering staff. In 1962, Air Force civil engineers serving in the 2d Air Division numbered 7 officers and a staff of 128; by the end of 1963, the number of personnel had risen to 14 officers and 1,400 persons.[490] Initially, the PACAF Deputy Chief of Staff for Civil Engineering based in Hawaii was designated to provide planning, programming, design guidance, and construction oversight for all Air Force facilities requirements throughout Southeast Asia.[491] At that time, Col. H.J. "Fritz" Stehling served as the deputy. By 1967, Colonel Stehling's staff numbered 130, which was double the staff size from a year earlier.[492]

Responsibility for acting as construction agent was assigned to the Navy Officer in Charge of Construction (OICC) stationed in Bangkok, Thailand. The Navy already acted as design and construction agent for the Military Assistance Program in Southeast Asia and had access to design expertise through contract architect-engineer firms. The Air Force had prior experience working with the Navy Office OICC. The Air Force typically defined the requirements, which were submitted to the Navy OICC, who oversaw preparation of designs and drawings. The drawings were submitted for Air Force review either at the Thirteenth Air Force Headquarters in the Philippines or at PACAF headquarters in Hawaii. After review and comment on the drawings, the Navy OICC contracted the work, typically using local contractors. Air Force personnel traveled to the job location to inspect and accept the work and had no in-house expertise in construction in South Vietnam.[493]

During 1962, the Navy OICC established a Deputy in Charge of Construction in Saigon to supervise U.S. military construction in South Vietnam. During this early period, one goal of U.S. involvement was to strengthen the local economy by using local contractors for construction work. However, by the end of 1962, the in-country contractor capability was saturated and the Navy awarded a cost-plus, fixed-fee contract to a U.S. joint venture construction firm Raymond, Morrison-Knudsen (RMK), which was enlarged in 1965 to include Brown and Root and A.J. Jones (BRJ). The expanded joint venture not only managed construction at existing air bases, but also was tasked to construct new air bases in South Vietnam.[494] The limited number of Army construction troops available in the combat zone required reliance on contractors in the combat zone for the first time in modern warfare. By late 1966, 52,730 personnel representing RMK-BRJ were working in Southeast Asia. The contractors were supported by over $100 million of in-country construction materials and nearly the same amount of equipment. During 1966, the RMK-BRJ completed approximately $40 million worth of construction projects per month.[495]

Before 1965, construction was focused on upgrading existing host country air bases in Southeast Asia with funding through the Military Assistance Program. Between early 1965 through early 1968, the buildup of U.S. Air Force personnel required new construction on five existing Vietnamese bases occupied by the U.S. Air Force (Tan Son Nhut, Bien Hoa, Da Nang, Pleiku, and Nha Trang) and five new air bases, four in South Vietnam (Cam Ranh Bay, Phan Rang, Phu Cat, and Bin Thuy) and one in Thailand (U Tapao). The Air Force required one additional air base, which was constructed at Tuy Hoa entirely by the Air Force. New construction used MCP and funds for minor new construction costing up to $25,000. Additional funding was available through operations and maintenance. In FY64, MCP funded $13 million; by FY67, MCP reached $100 million.[496] Between 1965 and the latter part of 1968, new construction totaled $284 million.[497]

Specific rules governed each funding category. In the case of MCP, preparation of MCP documents was cumbersome and time consuming. Each project had to be scoped, designed, and costs estimated. The project paperwork was forwarded to MACV, which forwarded the package on to PACAF and Air Force Headquarters. The MCP was reviewed at Air Force Headquarters, the Department of Defense, then submitted to the U.S. Congress, where the MCP was reviewed by committees and funds were appropriated for projects at specific locations. Funding contingency projects through MCP, even an emergency MCP, was time consuming and complex. Projects, which were planned months in advance, had the potential to be no longer needed by the time of their approval due to the fast-pace of the contingency situation.[498]

Congress recognized some of the limitations of the MCP for contingency situations and relaxed some funding restrictions. It allowed the Secretary of the Air Force to approve funding for emergency new construction costing below $50,000 and the Secretary of Defense to approve the same type of construction ranging between $50,000 and $200,000. By 1964, the new approval process was flooded with funding requests and the system was streamlined through PACAF. By 1965, the Secretary of Defense further relaxed the normal MCP requirements to permit Service construction programs based on operational requirements. The Air Force was able to change approved project locations, modify scopes of work, or add new projects within a $1 million limit if those costs were captured through savings on other projects or through the elimination of low priority projects.[499]

The improved response time for the MCP was reflected in the experience of 3d Air Division of the Strategic Air Command (SAC). When SAC received the mission for conventional bombing in Vietnam, 3d Air Division civil engineers began to identify and scope supporting facilities required for bombers. The Civil Engineer Programming Team worked with the SAC engineers to prepare programming documents. Fourteen projects in the first phase of the construction program, estimated at $1.5 million, were submitted to Air Force Headquarters for review by July 1, 1965. In August 1965, the projects were approved by Congress. The projects were submitted to the Navy OICC, Marianas, who selected an architect-engineer firm to expedite design. Design and construction surveillance of the projects were delegated to the 3d Air Division, which assumed full authority to represent SAC and to see the projects to completion. The OICC worked to streamline design work and required only 50 and 100 percent technical reviews. When possible, design and construction were undertaken simultaneously. The projects included in Phase I were completed by July 1966 and averaged 8.8 months from project programming to turnover to SAC. Phase II projects, totaling $7.5 million, took an average time of 11.2 months from programming through construction under MCP.[500] After the FY66 MCP, funds were awarded to the Armed Forces in lump sums, which provided even greater flexibility in contingency construction situations.[501]

In early 1966, MACV established a director of construction to reduce inter-service competition for resources, improve responsiveness, and establish equitable priorities for competing programs. MACV-4 (Logistics) included civil engineering personnel with centralized control over the MCP. The office was headed by an Army general, who was authorized to exercise flexibility in establishing priorities and allocating resources. Approximately 25 percent of the personnel in the MACV Director of Construction office were Air Force civil engineers. The MACV Director of Construction exercised flexibility over the approved construction programs based on current operational requirements.[502] By 1966, all in-country U.S. Armed Services submitted their construction requirements to the MACV Director of Construction.[503] To facilitate oversight of construction contracts, the Air Force established Air Force Regional Civil Engineer (AFRCE) offices in Southeast Asia and augmented civil engineering staff levels through architect-engineer services.[504] By early 1965, PACAF recognized the difficulties of span of control and established an AFRCE office in Bangkok, Thailand, adjacent to the Navy OICC offices on April 1, 1965. The AFRCE personnel assisted in planning and monitored construction being completed for the Air Force by the Navy OICC in both Thailand and the Republic of Vietnam. As the work continued to expand, Headquarters PACAF established a separate AFRCE office in Saigon in July 1965 to handle work in Vietnam only.[505] By the end of 1965, the Saigon AFRCE had 12 officers, 9 NCOs, and 30 contract architect-engineers from Daniel, Mann, Johnson and Mendenhall, an architect-engineer firm from Los Angeles, California.[506] The Bangkok AFRCE was led by Col. Gus J. Pappas, and had 12 officers, 6 NCOs, 1 Department of the Air Force civilian, and 23 contract architect-engineers. Even with these personnel increases at the AFRCEs, the planning and oversight of the build-up in Southeast Asia struggled and the lines of communication were confusing. Also, the 2d Air Division Civil Engineering staff was small and did not have control over the AFRCEs.[507]

Things began to change in February 1966, when Col. (later Brig. Gen.) Archie S. Mayes was assigned as Director of Civil Engineering at Headquarters, 2d Air Division (replaced by Seventh Air Force on April 1, 1966), which reported to MACV at Tan Son Nhut AB, Saigon. Colonel Mayes was hand-picked for the job by General Curtin because of his command-level experience. General Mayes later recalled,

> He [General Curtin] was down at Langley at one of my conferences. When it was over I was taking him to the airplane. We stood underneath the wing of the airplane, and he said, "That Vietnam thing is getting completely out of hand. We don't have a person out there who has the command-level experience to run it." He said, "I've got to have one of you guys. I think you're it. Will you volunteer?" I said, "General you cut the orders and I'll go."[508]

When Colonel Mayes arrived to assume his new position, a letter awaited him from PACAF that placed "everything in civil engineering in the whole country under his autonomous control."[509] Most staff assigned to the 2d Air Division Civil Engineering Directorate were on 120-day temporary duty assignments and job continuity was non-existent. Colonel Mayes imposed order on the Air Force administrative structure to accomplish the ongoing air base construction required for the buildup required to accommodate U.S. aircraft and personnel. As Director of Civil Engineering, Seventh Air Force, Colonel Mayes was responsible for the base civil engineering squadrons on all U.S. Air Force occupied bases and their performance in meeting the day-to-day support and challenges of operating functioning bases. With PACAF authorization, the AFRCE office under Col. Joe Kristoff in Saigon reported to Colonel Mayes. The AFRCE in South Vietnam developed the technical criteria needed for construction projects and submitted them to the Navy OICC, reviewed work developed by architect-engineer firms throughout the design process, monitored construction, and provided on-site oversight to guarantee that the work met acceptable standards at the time of beneficial occupancy.[510] Resident AFRCEs were placed on each of the nine air bases to oversee new construction. The tenth air base was Tuy Hoa, where an Air Force site resident engineer was in charge of construction. Resident AFRCEs were delegated responsibility to make field changes in scope and design that did not impact project costs. In addition, the AFRCE established Technical Assistance Teams to support Resident AFRCEs and base civil engineers in solving construction problems on the bases as needed. In addition to these responsibilities, Colonel Mayes oversaw the activities of the RED HORSE squadrons while in-country and the Turnkey Project to construct Tuy Hoa AB.[511]

As Director of Civil Engineering, Colonel Mayes developed a system to keep abreast, on a daily basis, of projects, programs and developments within the organization and on the bases. The Directorate also established a control room, which became the central point for tracking the status of Air Force activities. From the control room, personnel monitored the construction program, allocation of funds, scheduling of occupancy, and the design, programming, and requirements for new construction and selected operations and maintenance projects.[512]

Air Force civil engineers serving in South Vietnam worked in a combat situation in a war zone. While not typically on the front lines of combat, Air Force civil engineers stationed at air bases were subject to enemy attacks as part of their day-to-day duties. Some lost their lives. On April 24, 1965, Maj. Theodore R. Loeschner died while piloting an air transport mission in Thailand. Major Loeschner was a former civil engineering assistant professor at the Air Force Academy. Lt. Col. William H. Bordner was the first civil engineer officer killed by enemy action in Vietnam when he stepped on a booby-trapped phosphorous grenade as he descended from a helicopter on February 16, 1966 to conduct a site survey during the planning of Phu Cat AB.[513]

Prime BEEF

The establishment of mobile engineering squadrons to augment base level support in contingency situations was proposed by PACAF early in 1963. The mobile engineering squadrons were a strategy to augment low staff levels; each was manned by specialists, including carpenters, electricians, plumbers, and diesel plants and equipment operators. Reflecting on experiences in South Vietnam during 1961-1962, Col. I.H. Impson, Assistant Chief of Staff, Civil Engineering, PACAF, wrote, "We in PACAF could certainly use a Mobile Civil Engineering Squadron or two."[514] On June 17, 1964, PACAF sent a letter to U.S. Air Force headquarters outlining the needs, purpose and mission for hand-picked civil engineering teams that would undertake emergency repairs and other work in combat areas.[515] As

(above) Members of the first Prime BEEF Team deploying to South Vietnam in 1965.

(right) Prime BEEF members from Air Defense Command bases construct ARMCO revetment to protect aircraft at Tan Son Nhut AB, South Vietnam.

described earlier in this chapter, Project Prime BEEF was under development by the Air Staff at this same time. Project Prime BEEF was a manpower review that resulted in re-posturing civil engineering staffing and the formation of emergency teams. Prime BEEF teams were organic to the Air Force civil engineering organization and used manpower resources already within the organization or that could be developed readily. The concept of emergency civil engineering teams was first used during deployment to the Dominican Republic. The concept was tested extensively and proved valuable in sustained support of the Air Force civil engineering construction and support activities in South Vietnam and Southeast Asia.[516]

In 1965, Air Force civil engineers with PACAF were faced with dramatically increased facilities requirements. A new base at Cam Ranh Bay was under construction and new and expanded facilities were required at occupied air bases. During 1965, Airmen billets increased from 5,520 to 18,900, warehousing requirements rose from 29,200 square feet to 171,700 square feet, and ammunition storage requirements expanded from 65,000 square feet to 170,000 square feet. Additional POL facilities were required as well as expanded utilities, such as electrical power and water and sewage.[517] PACAF desperately needed additional civil engineering assistance in Southeast Asia.

Bases in Vietnam were becoming dangerously overcrowded as aircraft were parked so closely that they posed a safety risk. On the morning of May 16, 1965, a fully-armed B-57 was taxiing out through an open ramp for an armed reconnaissance mission at Bien Hoa AB. Suddenly, the B-57's munitions began to explode and set off a series of sympathetic explosions in nearby aircraft. The conflagration rained down burning fragments, fuel, and incendiaries on the airfield, killing 28 Americans and 6

ADC Prime BEEF team gets top-level assistance in building aircraft revetments from Lt. Gen. Joseph H. Moore, Commander of 2d Air Division, as Lt. Col. Francis. H. Torr "supervises."

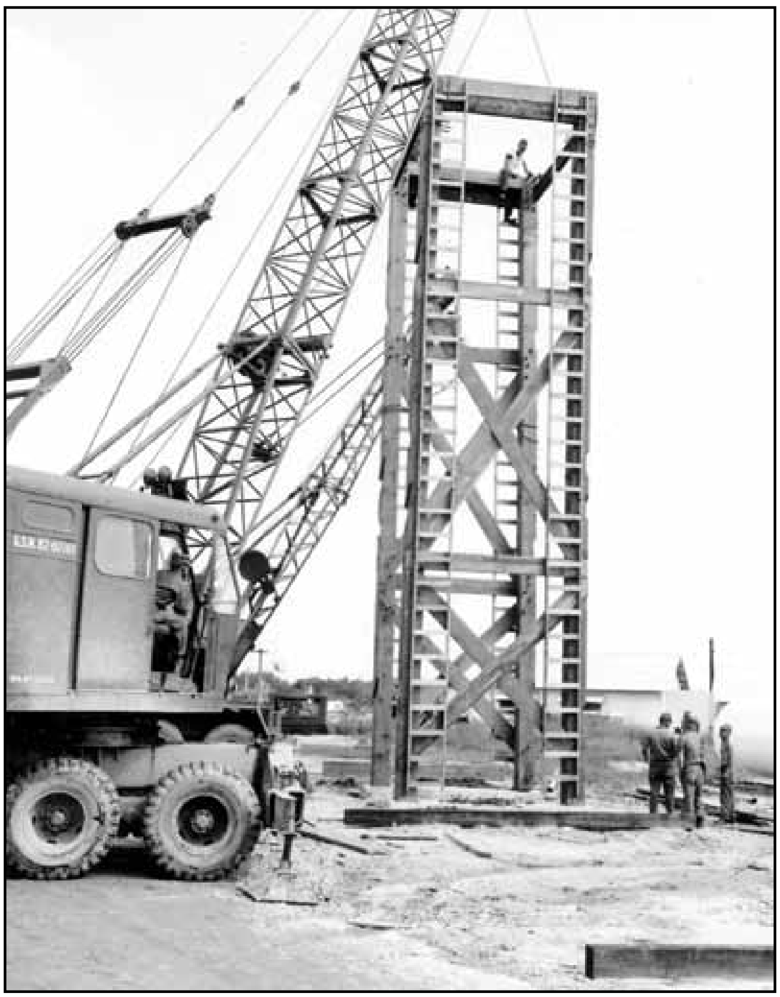
Table 3.3 Prime BEEF Teams Deployed Between 1965 and July 1966 to Southeast Asia

Prime BEEF Unit	Unit Activity During Vietnam War	Activities
Prime BEEF 1	73 personnel from ADC, ATC and SAC divided into 3 teams deployed August 1965 to December 1965 at Tan Son Nhut, Bien Hoa, and Da Nang	Installed 12,000 linear feet of steel revetments, steel blast deflectors, concrete, dormitory hutment at airfields
Prime BEEF 2	An 18-man team from MAC deployed September 1965 to January 1966 to Tan Son Nhut	Plumbing, water supply, sewage facilities, laid 12,000 linear feet of water pipe, 450 linear feet of sewer lines, plumbed 9 latrines
Prime BEEF 3	225 personnel divided into 6 teams deployed October 1965 to February 1966 to 6 air bases in South Vietnam	General construction, beddown housing (hootches and tents) for 4,900 Airmen, constructed 54,000 square feet of support facilities, laid 3,000 square yards of concrete, prepared base and laid 96,2000 square yards of PSP
Prime BEEF 4	4-man team from SAC, ATC, HQ COMD, deployed October 1965 to February 1966 to AFRCE office, Saigon	Designed POL facilities
Prime BEEF 5	120-member team from AFLC, AFSC, TAC, ADC, ATC deployed November 1965 to March 1966 to Takhli, Thailand	General construction
Prime BEEF 6	29-man team from MAC deployed January to May 1966 to Tan Son Nhut and Bien Hoa ABs	1,600 feet of revetment construction
Prime BEEF 7	29-man team from AFSC deployed January to May 1966 to Korat, Thailand	Revetment construction
Prime BEEF 8	12-man team from ADC deployed February to May 1966 to Tan Son Nhut and Bien Hoa Abs	Plumbing
Prime BEEF 9	21-man team from SAC, MAC, TAC, ADC, HQ COMD, ATC, AFSC, AU deployed February to June 1966 to Tan Son Nhut AB	Electrical work
Prime BEEF 10	120-man team from AFSC, ADC, ATC, TAC deployed February to June 1966 to 7 air bases in South Vietnam	General construction of cantonment facilities
Prime BEEF 11	50-man team from SAC deployed March to July 1966 to Tan Son Nhut AB	General construction
Prime BEEF 12	40-man team from SAC deployed March to July 1966 to Da Nang AB	General Construction
Prime BEEF 13	58-man team from ADC, TAC deployed March to July 1966 to 4 air bases in South Vietnam	Revetment construction
Prime BEEF 14	90-man team from ATC, MAC, TAC deployed April to August 1966 to 4 bases in Thailand	General construction
Prime BEEF 15	30-man team from AFLC, HQ COMD deployed May to September 1966	General construction
Prime BEEF 16	45-man team from SAC and AAC deployed May to December 1966 to NRP, Thailand	General construction
Prime BEEF 17	45-man team from SAC deployed May to September 1966 to U-Tapao, Thailand	General construction
Prime BEEF 18	1 person from ADC deployed May to September 1966 to Tan Son Nhut AB	Deployed to be Prime BEEF chief
Prime BEEF 19	17 persons from SAC. TAC, ADC, HQ COMD, AFLC, AFSC, AFSS deployed May to October 1966 to Tan Son Nhut AB	Assist Seventh Air Force staff function

Table 3.3 Prime BEEF Teams Deployed Between 1965 and July 1966 to Southeast Asia (continued)

Prime BEEF Unit	Unit Activity During Vietnam War	Activities
Prime BEEF 20	1 person from AFLC deployed June 1966 to October 1966 to Bangkok, Thailand	Assist AFRCE
Prime BEEF 21	50-man team from ATC deployed June to October 1966 to Nha Trang AB	General construction
Prime BEEF 22	50-man team from TAC deployed June to October 1966 to 3 air bases in South Vietnam	General construction
Prime BEEF 23	50-man team from SAC deployed June to October 1966 to Tan Son Nhut AB	General construction
Prime BEEF 24	50-man team from ADC deployed June to October 1966 to Pleiku AB	General construction
Prime BEEF 25	13 persons from SAC, TAC, HQ COMD, MAC, ADC, AFSC, ATC, AU deployed July to November 1966 to Tan Son Nhut.	Electrical distribution

Sources: Prime Beef Deployments, 1965-1976, Files of AFCEC History Office, Tyndall AFB, Florida; 1st Lt. John G. Terino, "Vietnam Report No. 2," Air Force Civil Engineer, Vol 7, No 2, May 1966, 4-5; Lt. Col. Howard B. Arnold, Jr. "A New Image for the AFCE in Vietnam," Air Force Civil Engineer, Vol 7, No 2, May 1966, 6-7.



A Prime BEEF team constructs a water tower at Da Nang AB, November 1966.

Vietnamese and injuring 100. The Explosive Ordnance Disposal career field suffered four casualties when delay-fused bombs detonated while the team attempted to render them safe. The casualties that day included: Capt. Ernest McFeron, TSgt. Claude H. Bunch, SSgt. David L. Hubbard, Jr., and Sgt. Aaron G. Fidiam, Jr. The explosions also destroyed or damaged more than 40 aircraft.[518]

The first Prime BEEF teams deployed to Southeast Asia in August 1965 to construct ARMCO steel-bin revetments at Tan Son Nhut, Bien Hoa, and Da Nang air bases (Table 3.3). CECOG was not yet in existence, so the Air Staff required ADC, ATC, and SAC to each provide a 25-person team. Headquarters ADC and ATC hand-picked team members from base civil engineering organizations from several of their bases and led by Lt. Col Francis E. Torr and Maj. Forrest M. Mims, Jr., respectively. SAC formed its team from a single base civil engineer squadron at Biggs AFB, Texas, and was led by Capt. Charles H. Martin. In addition, SAC provided one construction engineer and two site development technicians from March AFB, California. These personnel acted as an advance party for the deployment. Officers and key NCOs were briefed on the team's mission and the revetment program at Eglin AFB, Florida. The importance of the mission in terms of the overall Prime BEEF program also was stressed to the team members. The advance survey party led by Capt. Richard V. Bratton arrived at Tan Son Nhut AB on August 2, 1965. On August 5, the advanced party consisting of one NCO from each team arrived at Tan Son Nhut AB. The remaining personnel arrived in-country on August 8. All personnel were armed with M-16 automatic rifles. ADC personnel remained at Tan Son Nhut AB, while ATC personnel traveled to Bien Hoa AB, and SAC personnel traveled to Da Nang AB.[519]

In assembling the Prime BEEF teams destined for Southeast Asia, Civil Engineering leaders deviated from the program's guidelines as set up in Air Force Regulation 85-22, "The Prime BEEF Program." As described earlier in this chapter, five types of Prime BEEF teams were established in AFR 85-22: Recovery, Flyaway, Contingency, Missile, and Logistical. Although Flyaway or Contingency teams were designed for this type of situation, they were not called upon to serve in Southeast Asia. This was done because no single base-level team could have assembled the skills and experience required. Maj. R.S. Dobbins, Prime BEEF Chief in Vietnam in 1966, saw this as a logical step in the growth and progression of the program. The flexibility demonstrated with the first few teams set a pattern for future Prime BEEF deployments.[520]

Personnel on Prime BEEF teams were deployed on temporary duty for 120 days. The first teams were equipped only with what could be carried, making it essential for the teams to rely on base civil engineering, civilian contractors, other services, and even the Royal Australian Engineers for support at their assigned locations. Equipment and vehicle issues were the primary problem for most early Prime BEEF teams. The paucity or poor condition of items, when available, such as forklifts, front-end loaders, and cranes were often cited in the team's after-action reports.[521] Between August 1965 and July 1966, 25 Prime BEEF teams comprising 1,231 personnel, were deployed to Southeast Asia (Table 3.3). Typical projects included the construction of revetments, general construction, plumbing and water, electrical distribution, and staffing support. In all, 50 Prime BEEF teams deployed between August 1965 and January 1969, totaling 1,839 personnel.[522]

In a 2000 oral history, retired Brig. Gen. Archie S. Mayes discussed his experience with Prime BEEF while in Vietnam: "When I got to Vietnam [in February 1966] the only way they were surviving was with Prime BEEF teams. We had an electrical team, a plumbing team, and building erection teams, all taken out of the bases in the states. I don't know how many, but we might have had 15 or 20 teams on the ground when I got to Vietnam."[523] By the end of December 1966, more than 1,350 Prime BEEF personnel on 35 teams were deployed overseas to support base civil engineering operations.[524] The catalog of Prime BEEF accomplishments included construction of 27,000 linear feet of revetments; 9,300 square yards of blast deflectors; 3,700 square feet of concrete ramps; 190 one-story wood or metal buildings; 50 two-story wood buildings; 44,000 square feet of tent frames; 1,800 linear feet of sanitary sewers; 19,100 linear feet of water mains; 7,100 linear feet of electrical distribution systems; a modular 100-bed hospital; and, wells, field latrines, and septic tanks.[525]

Maj. Gen. Robert H. Curtin was favorably impressed by the performance of the Prime BEEF teams. He passed along a compliment from one unnamed Air Force commander for all to read in the *Air Force Civil Engineer*:

> The team concept wherein, team work, acknowledgement of accomplishment, esprit de corps and all other necessary ingredients for highly professional performance appears to be well founded in the establishment of these [Prime BEEF] teams.[526]

<u>The Establishment of RED HORSE</u>

In a May 10, 1965 memorandum, the Secretary of Defense queried the Secretary of the Air Force regarding the Air Force capabilities for constructing an operational airfield in Vietnam within a month. The Secretary of Defense had information that the U.S. Marine Corps was building a four squadron operational airfield on undeveloped acreage near Chou Lai, Republic of Vietnam, in 28 days. Secretary of Defense Robert S. McNamara asked "Does the Air Force have the similar capability? If not, what can be done to develop it?"[527]

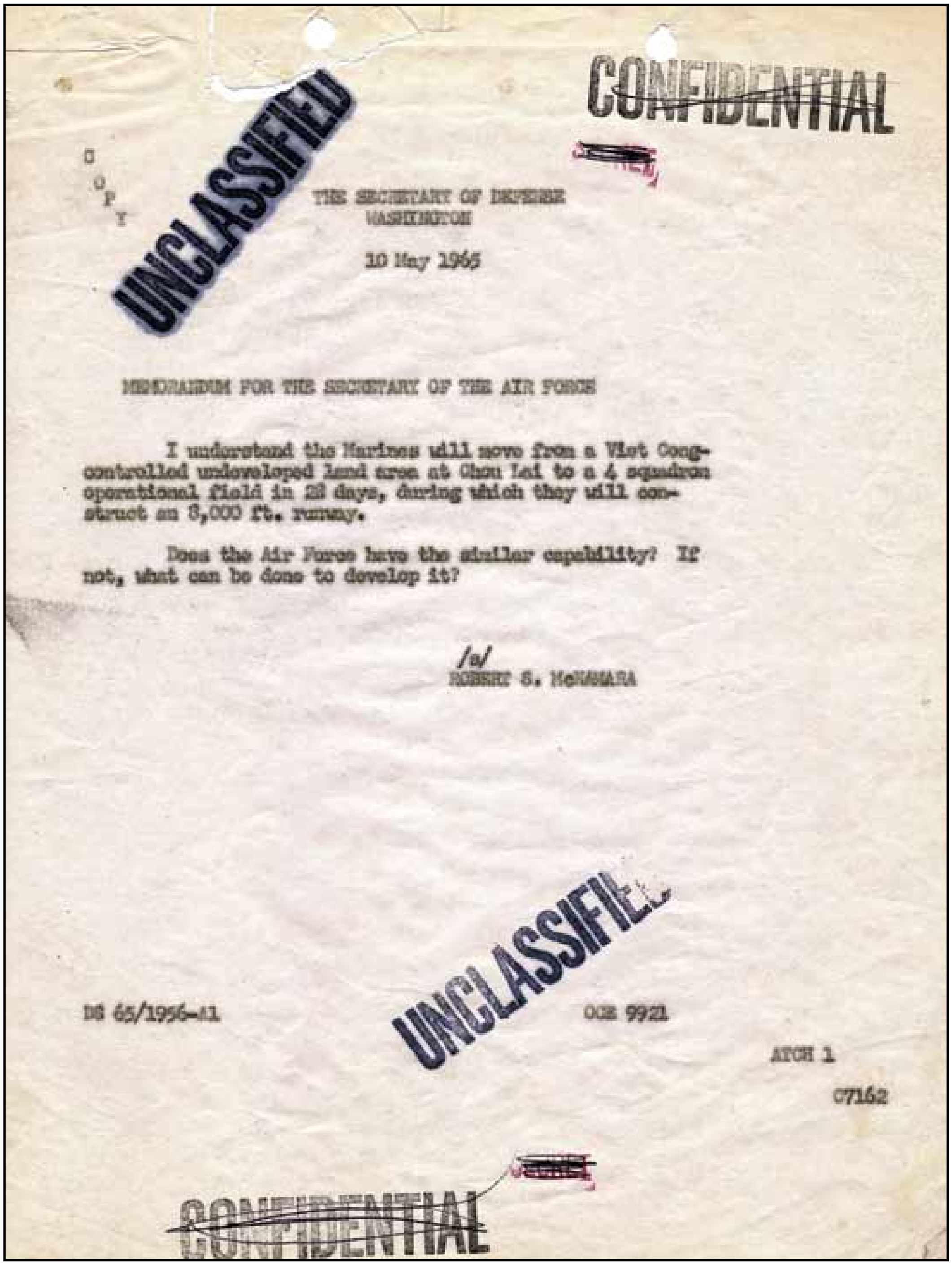
At that time, the answer to the question was "no" due to the restrictions codified in the 1957 DoD directive 1315.6, which established that troop construction for the Air Force in contingency situations would be supplied by the Army. The Air Force was restricted to emergency repair of bomb damaged air bases. The Air Force had no organic troop construction units and access to only limited Army troop construction units in the combat zone. The scarcity of Army troop construction units was traced to the Army decision to reduce the number of its dedicated troop construction units and assign construction duties to the Reserve and National Guard. During the Vietnam Conflict, a national policy decision was made not to mobilize Reserve and National Guard units. By June 1965, the first two "regular" Army construction battalions were active in South Vietnam. Army troop construction capability grew to 26 non-divisional battalions, but these troops were committed to meeting Army requirements and provided only limited support to the Air Force.[528]

Troop construction support was preferred for operating in a combat zone. Troops were trained to operate in austere conditions, around potential enemies, and, in the case of Airmen, around operating airfields. Contractors typically were tied to fixed bases, required security, and were focused on specific projects. Construction troops, on the other hand, were broadly trained and were deployable wherever needed.[529]

Maj. Gen. Robert H. Curtin began to cultivate the construction capabilities suggested by the Secretary of Defense. Further incentive to address construction support within the Air Force was provided by an August 11, 1965 letter from Col. Henry J. "Fritz" Stehling, command civil engineer at PACAF, to Air Force Headquarters outlining the requirements in Southeast Asia for heavy construction and repair capability based on the current conditions of the buildup.[530] General Curtin was under additional pressures from his own boss, General LeMay, Chief of Staff of the Air Force, who wanted two or three more bases built in the Republic of Vietnam. According to General Curtin, "[General LeMay] said, 'You've got to get them built.' I said, 'All right.' He said, 'Our commanders over there can't handle it. You've got to get in the act.' So, I got in the act." After checking with the U.S. Army Chief of Engineers and the Navy, General Curtin knew that those agencies were overwhelmed with construction requirements of their own. He said, "We have no choice. We've got to do this, and the only way we can do it is heavy maintenance, and if we have to do some construction with heavy maintenance, we'll just have to let the definitions stand by themselves."[531]

The Civil Engineering Directorate began work on the issue and on September 14, 1965 completed a study entitled, "Prime BEEF Heavy Repair Squadrons." The study's objectives were:

1. To create a rapid response capability, within the Air Force, to augment base engineer forces in the event of heavy bomb damage or disasters, as well as accomplish major repairs where contract capability is not readily available. As a by-product of this capability "expeditionary airfields", [sic] using AM-2 matting, and austere cantonment facilities could be built.
2. To create a capability which would not duplicate any existing effort, but "fill the gap" until this effort is made available to the Air Force.
3. To create a capability that will remain organic to the Air Force.[532]



~~CONFIDENTIAL~~

UNCLASSIFIED

C O P Y

THE SECRETARY OF DEFENSE
WASHINGTON

10 May 1965

MEMORANDUM FOR THE SECRETARY OF THE AIR FORCE

I understand the Marines will move from a Viet Cong-controlled undeveloped land area at Chou Lai to a 4 squadron operational field in 28 days, during which they will construct an 8,000 ft. runway.

Does the Air Force have the similar capability? If not, what can be done to develop it?

/s/
ROBERT S. McNAMARA

UNCLASSIFIED

DS 65/1956-A1 OCR 9921

ATCH 1

07162

~~CONFIDENTIAL~~

Memo from Secretary of Defense Robert S. McNamara that led to the creation of RED HORSE.

Table 3.4 Timeline of RED HORSE Formation

Date	Activity
September 23, 1965	Air Staff approved concept, TAC assigned training responsibility
September 30, 1965	Commanders of new squadrons named
October 1, 1965	Formal activation of 554th and 555th Civil Engineering Squadrons (Heavy Repair)
October 15, 1965	HQ TAC completed programming plan outlining time table, staffing, training requirements
November 15, 1965	Advance cadre in place
December 1, 1965	Training equipment in place, 80 percent manning in place, unit training initiated
December 15, 1965	100 percent manning in place
January 1, 1966	Operational equipment in place
January 26, 1966	RED HORSE "graduation"
February 1, 1966	Deployment to South Vietnam

Source: "Project RED HORSE," Air Force Civil Engineer, Vol 7, No 2, May 1966, 2-4.

The overall recommendations were to immediately develop two Prime BEEF Heavy Repair squadrons from existing Air Force resources and that action be initiated for follow-on squadrons in FY68.[533]

The new civil engineering squadrons were activated on October 1, 1965 by the Secretary of the Air Force.[534] General Curtin described the purpose of the civil engineering squadrons,

> These squadrons (400 officers and men each) are to provide a continuing on-site and heavier capability to meet operational Civil Engineer needs of the 'combat zone.' These units are not intended to, nor do they in fact, minimize our reliance on Army Engineer Construction Battalions for initial expeditionary airfield work. Rather, these units fill an existing gap in the broad spectrum of Civil Engineering capabilities needed by the Air Force to support its operational missions. Individual replacements for these units will be provided via our Prime BEEF concept but otherwise there is no relationship between these large PCS (permanent change of station) units and our small TDY Prime BEEF teams.[535]

According to General Meredith, the Air Force "had to develop a concise, hard-hitting, combat-ready, highly-skilled, mobile, and self-contained unit that could survive under the most demanding missions, worldwide." These were self-sufficient squadrons that were fully equipped and provisioned. The timetable to form the new civil engineer squadrons was aggressive - 60 days to select, train, equip, and deploy the new civil engineer squadrons (Table 3-4).[536]

The experiences of aviation engineers during World War II were in the minds of several participants in setting up the new squadrons.[537] For example, the size of the RED HORSE squadrons was a topic of discussion. As General Curtin recalled,

> Tom Meredith and others sat around, and we came up with plans. We used the Corps of Engineers construction battalion as an example. At that time they had about 812 people in a battalion. We said that was too big. We went on the philosophy that the unit would be supported medically, for food service, and so on, by a larger unit, the flying unit, presumably. You might have to shift for yourself for a short period of time, but then let the wing provide the advanced cooking arrangements, instead of you having it internal. We said, "Let's get it down to half the size," so that's how the 404 number came about, from the 812 Corps of Engineers battalion to the 404.[538]

RED HORSE SONG

Written by Jeanne & Clark Ironmonger
Arranged for band and the Singing Sergeants by CMSgt Floyd Werle, Director, USAF Band, 1965. First performed at Cannon AFB, January 26, 1966.

Up and Out
Up and Out
All you RED HORSE men
Up and Out.
Pass the Word
Pass the Word
We've a job
In case you haven't heard.

Up and Out
Hear us Shout
We can do it with or without
Let them know
Let them know
That for RED HORSE men
The word is Go.

Chorus:

For the RED HORSE team is on the way
You can bank on us to save the day.
We can fix and we can fight
We do both with all our might.
You'll be back on track without delay
We're the RED HORSE forces man-to-man
And we're right there when it hits the fan.
Give us grader or grenade
And you know you've got it made
With RED HORSE Airmen of the USA.

General Meredith and Colonel O'Keefe worked with AFLC to set up logistic support and to procure equipment for the two new RED HORSE squadrons. General Meredith described how the Civil Engineering Squadrons were named RED HORSE,

> One day we said, "What are we going to call this?" Warrant Officer John Bennett, who's dead now, was my heavy equipment man. He and [Col. Truman] O'Keefe and I were sitting there and he said, "What's faster than a bull?" You know we had the black bull as a symbol for Prime BEEF. I said, "A horse." He said, "What color do you like?" I said, "Red." It took us two days to come up with the acronym, Rapid Engineer Deployable Heavy Operational Repair Squadron, Engineer.[539]

TAC was assigned to train the personnel designated for the new RED HORSE squadrons. Then-Col. Archie S. Mayes was TAC Deputy Chief of Staff, Civil Engineering and his office oversaw the training schedule and the logistics of assembling training equipment.[540] Cannon AFB in New Mexico was chosen as the training location for the 554th and the 555th. General Curtin selected the first commanders, Col. James Conti and Lt. Col. Marvin Plunkett, and Colonel O'Keefe worked with Air Training Command at Randolph AFB to select the troops to fill the squadrons. Personnel were selected from the best Prime BEEF teams. Squadron commanders reported to the base and troops began a 60-day training course prior to deployment to South Vietnam. On January 26, 1966, at the end of the 60 days of training, the 800 troops were feted at a pre-deployment party and serenaded with the "RED HORSE Song."[541]

While training was in progress, General Meredith and Colonel O'Keefe worked closely with AFLC to assemble the equipment needed by the new squadrons. The assembly point for the equipment was Robins AFB, Georgia. Equipment for the first two RED HORSE squadrons was collected from whatever supplies were available at stateside bases. However, no base personnel were available for equipment overhaul. General Meredith contacted a Navy captain in charge of the SEABEE center at Gulfport, Mississippi, to overhaul the equipment to assure its functionality in the field. The only condition that General Meredith made to his request was that the equipment was not to be painted olive drab. Some new equipment had to be procured from the private sector. General Meredith made inquiries with normal suppliers, and received an unsolicited offer of help from Miles Golbransson, a representative of International Harvester Company. Mr. Golbransson vowed, “I’m here on behalf of my company to tell you that we will provide construction equipment, any quantity you need, even if we strip our showroom floors, and put it on the ship at Gulfport, Mississippi.” Working through the Army procurement office, International Harvester won the contract and then shipped the off-the-shelf equipment to Gulfport, Mississippi. General Meredith himself drove a payscraper through two states to reach the port on time.[542]

Outfitting those first RED HORSE squadrons was quite a job. As General Meredith recalled,

> You know, at one time at Warner Robins [AFB], they had 20 miles of railroad totally stacked with RED HORSE equipment. We sat there and went through the bill of material, every piece of construction equipment that we thought we could put on a ship, from cement to lumber to plywood to nails and screws and everything. We sat down with a nurse up in a motel room one night and came up with a list of medical supplies and medical equipment. This was the first totally self-supporting Air Force unit ever, with medics and everything in it. For the mess equipment, I went down and got an old mess sergeant and gave him a half bottle of whiskey. He was half drunk, but he put down everything we needed for mess equipment. As soon as he put it down, we’d put it back into the AFLC group and, boy, they ordered it and had it packaged.[543]

When it came to transporting the equipment and materiel to the combat zone, General Meredith suddenly remembered to make the shipping arrangements.

> Then somebody over at the AFLC group was talking, and they said something that sounded like the word “ship,” and I said, “Oh! Ship! We haven’t got a damn ship! We’ve been doing all this, and we haven’t put in a request for a ship”…I said, “Come on.” We went up to see a lady on the top floor at AFLC [in Building 262 at Wright-Patterson AFB]…We walked in, and there was a gray-haired lady sitting

RED HORSE Mascot: One and a half

During the Vietnam War, the 554th RED HORSE Squadron acquired a live mascot in the form of a small pony. The squadron was stationed at Phan Rang AB in Vietnam when they adopted “One and a Half.” He was fed oats and hay as well as an occasional cigarette. During special events “One and a Half” even wore a red blanket that displayed chief master sergeant stripes.[547]

Later, he moved with the 554th to U Tapao AB, Thailand.

> there. I said, "I'm looking for the head person here." She said, "I'm it." I said, "Fine. I need a ship." She looked at me and said, "Do you know any more funny jokes?" I said, "No, this is for the RED HORSE troops." She said, "I've heard of them, but what priority do you have?" I said, "2D, by the Secretary of Defense." She said, "Can you prove that?" [Secretary of Defense Robert S.] McNamara, when he gave us the initial authorization for RED HORSE, wrote it on the back of an envelope and put the priority on it…. She turned around and got on the radio and talked a bit. She said, "The *Adabelle Lykes* is coming around the tip of Florida. It'll go into Gulfport and will be there on this date. Can that handle it over the side?" I said, "If it's got 37 tons that'll swing over the side, that'll handle it. That's the tractor weight." They came back and said they could handle 40 tons. The Lykes Shipping Line hauled everything we ever hauled to Vietnam.[544]

On February 1, 1966, both the 554th and the 555th were transported to South Vietnam by military aircraft. The equipment and supplies were onboard ship headed westward across the Pacific Ocean.[545] The 554th, called "Penny Short," was deployed to Phan Rang and the 555th, called "Triple Nickel," was sent to Cam Ranh Bay. From the beginning, these two squadrons exhibited high morale and commitment.[546] While at Phan Rang, the 554th acquired a mascot. The 554th and the 555th RED HORSE squadrons were awarded outstanding unit awards, as well as Bronze Stars and other honors for their outstanding service.

Once the RED HORSE squadrons were in-country, General Curtin made a visit to the Chief of the U.S. Army Corps of Engineers, Lt. Gen. William F. Cassidy. As General Curtin told the story,

> I started telling him the philosophy behind the whole program. He said, "You can't do that. That's counter to the charter of the Corps of Engineers. We'll have to take it up with the Joint Chiefs. You won't be able to go ahead and do this at all. Besides, I don't think it can be done." I said, "General, it isn't a question of it could be done, it *has* been done." He said, "What do you mean it *has* been done?" I said, "We've already got two units in country." "How did you do that?" I said, "We just routed the ships and shipped them over there. We had to unload them ourselves." I said, "We asked for trucks and equipment from the Army to help us unload, but they couldn't afford them, so we had to go over the beaches." He said, "You've got two of them over there?" I said, "Yes." He said, "Well, then I won't bring it up at the Joint Chiefs. But I want to shake hands with you. And as soon as this war is over, you've got to get rid of those units." I shook his hand, like a dummy, I guess.[548]

554th and 555th Emblems

(above) *554th RED HORSE personnel take up AM-2 matting to expose the damaged base to begin repairs at Phan Rang AB, South Vietnam.*

(below) *A chapel under construction by the 554th RED HORSE Squadron at Phan Rang AB, South Vietnam.*

Col. (later Brig. Gen.) Archie S. Mayes, the TAC Director of Civil Engineering during the training of the RED HORSE squadrons, was transferred to serve as the director of Civil Engineering, 2d Air Division (later redesignated as 7th Air Force) in South Vietnam and arrived in-country about the same time as the RED HORSE squadrons. The RED HORSE squadrons were not dedicated to a particular base, but served a region. Once the RED HORSE squadrons had erected their own hard-back beddown facilities and set up their mess hall, they sought leadership in identifying other needed projects. One of Colonel Mayes' first actions was to call together 16 NCOs, assemble his overall organizational structure, and put the RED HORSE squadrons to work.[549] Colonel Mayes, supported by Col. (later Brig. Gen.) John D. Peters, became responsible for managing the activities of the first two RED HORSE squadrons.[550]

During 1966, four additional RED HORSE squadrons were activated and trained at Forbes AFB, Kansas, for deployment to Southeast Asia. The first two squadrons were followed by the 819th and the 820th RED HORSE squadrons, which were transported to Phu Cat and Tuy Hoa, respectively. The 823d followed and was based at Bien Hoa AB. The five units comprised a total of 2,000 troops. Later, the 556th RED HORSE was deployed to Thailand (Table 3.5).[551] By May 1967, Colonel Mayes was authorized to form the 1st Civil Engineering Group, a 60-man staff element, to oversee the activities of the five in-country squadrons. Col. Robert H. Carey became the first commander and worked under Colonel Mayes while he was HQ Seventh Air Force, Director of Civil Engineering.[552]

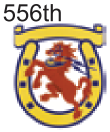
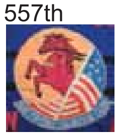
When Air Force leaders established the RED HORSE squadrons, it was to "provide emergency capability to repair airfield damage caused by enemy action or natural disasters, and that the squadrons are not designed for but will have a collateral capability to build expeditionary or temporary airfields and do other construction work of an emergency nature," according to Gen. John P. McConnell, Chief of Staff. In a hand-written note to CINCPACAF, General McConnell emphasized this point, "In other words, our squadrons can work on airfields after they are built & the Engineers and Construction & BuDocks people have left."[553] However, this stipulation did not last long.

By mid-1966, it was apparent that contractor services were overtaxed. The MACV Construction Director tasked the construction contractor to complete only the most basic airfield facilities items and primary utilities.[554] The remainder of the work would be accomplished by troop labor. This was not done in deliberate disregard of the Air Force policy, but out of necessity and at the request and consent of MACV.[555] At Phu Cat AB, the 819th CES (HR) completed the majority of the vertical construction including 600,000 square feet of pre-engineered metal buildings and wooden barracks and dining halls. The contractor completed the concrete runway, roads, and utilities. Another large project was the repair by the 554th CES (HR) of nearly one million square feet of aircraft parking space at Phan Rang AB.[556]

General Mayes summarized the status of construction on the new air bases vacated by the contractor in mid-1967, "Cam Ranh Bay was only partly finished, but more than most of the others. Phan Rang was only partly finished. Phu Cat practically nothing. Of course, Tuy Hoa was not involved." The

819th RED HORSE Squadron constructs hardened aircraft shelters at Da Nang AB, South Vietnam. (Courtesy of Col. Allen Sailer.)

Table 3.5 RED HORSE Activity During the Vietnam Conflict, 1966-1975

RED HORSE Unit	Unit Services During Vietnam Conflict	Selected Activities between 1966 and 1968
554th 	Activated October 1965; deployed February 1966 concurrently with 555th; stationed at Phan Rang AB, Vietnam; moved to Cam Ranh Bay AB February 1970; moved to Da Nang AB November 1971 to replace the 820th; was the last RED HORSE squadron to leave Vietnam; relocated to U Tapao AB, Thailand in June 1972; to Osan AB, South Korea in 1976.	Replaced AM-2 runway at Phan Rang; in 1967 became the first RED HORSE squadron with a concrete batch plant; constructed squadron facilities; completed 60,000 square feet of permanent base facilities including 67 dormitories, 26 latrines, 2 dining halls; installed 4 aircraft arresting barrier systems, road construction.
555th 	Activated October 1965; deployed February 1966 concurrently with 554th; stationed at Cam Ranh AB until 1970, then inactivated.	Repaired 20,000 square yards of AM-2 taxiway; constructed 35,000 square feet of living quarters, 57,000 square feet of maintenance shops; constructed 5,900 linear feet of revetments; completed 200-man hospital; installed 2 aircraft arresting barriers and 2 aircraft lighting systems, installed 19,600 linear feet of POL pipeline.
556th 	Established in 1966 and deployed in July 1966 to U Tapao AB, Thailand; inactivated late 1969.	Constructed taxiway-runway-apron complex at Nakhon Phanom AB; constructed dormitories, dining halls, and other facilities.
557th 	Established in April 1968 and deployed to Osan AB, South Korea; reassigned to Eglin AFB, Florida 1969; inactivated 1972.	Assisted in Air Force buildup in South Korea resulting from seizure of U.S.S. Pueblo; constructed aircraft shelters, modular facilities, revetments, and other mission-essential facilities.
560th 	Activated in November 1966 at Eglin AFB, Florida, inactivated 1970.	Provided replacement personnel training at Civil Engineering Field Activities Center, Eglin AFB, Florida.
819th 	Activated in February 1966 and deployed in September 1966 to Phu Cat AB; moved to Tuy Hoa AB to close it in 1970; moved in 1970 to Westover AFB, Massachusetts; moved to McConnell AFB, Kansas; moved to RAF Wethersfield, UK in 1979; inactivated in 1990; reactivated as an AF/ANG RED HORSE associate unit in 1997 at Malmstrom AFB, Montana.	Completed almost all vertical facility construction at Phu Cat AB; completed AM-2 matting on airfield; constructed revetments; constructed permanent living quarters for 1,276 people, and 2 dining halls; installed water purification plant and dug 2 wells; constructed shops, warehouses, and administration facilities; installed AM-2 ramp.
820th 	Activated in April 1966 and deployed in October to Tuy Hoa AB 1966; moved to Da Nang AB in 1969; moved to Nellis AFB, Nevada, in 1970.	Completed nearly 50 percent of construction at Tuy Hoa. Installed AM-2 matting; constructed RED HORSE camp and 58,200 square feet of permanent and temporary facilities; built 5 miles of road; installed temporary POL system; construction of revetments and ammunition storage area.
823rd 	Activated in 1966 and deployed to Bien Hoa AB in November 1966; inactivated in 1971, but reactivated at Eglin AFB, Florida, in 1972.	Built RED HORSE cantonment; constructed wooden facilities at Vung Tau and Pleiku; erected ammo and steel revetments; in 1975, built tent city at Eglin for 5,000 refugees of Vietnam.

Sources: Historical Division, Directorate of Information, HQ Seventh Air Force, Appendices IV-V of Activities 1967-1968, ca. 1968, Files of AFCEC History Office, Tyndall AFB, Florida; Lois E. Walker, "A RED HORSE Roundup," The CE, Vol 8, No 3, Fall 2000, 28-30.

Members of the 820th RED HORSE Squadron build a bunker at Dong Ha, South Vietnam. The person in the middle of the photo wearing a jacket is Airman 1st Class Larry R. Daniels. He later became the first Chief of Enlisted Matters for Civil Engineering in 1989.

RED HORSE squadrons inherited much of the contractor's equipment, as well as a quarry, an asphalt plant, and a concrete plant. General Mayes tallied up the work accomplishments of the RED HORSE squadrons, "with those five RED HORSE squadrons we went to it. We built all the rest of Phu Cat, finished out Cam Ranh Bay and Phan Rang, and then built things on the other bases."[557]

In his July 1967 *End of Tour Report*, Brig. Gen. Archie S. Mayes reflected, "Having trained the first two RED HORSE squadrons as the TAC Civil Engineer, I had the unique experience of assuming my new duties in Vietnam during the same month they arrived in-country…Today with its five squadrons under command of the 1st Civil Engineering Group, I believe RED HORSE represents one of the greatest and most successful advances in the history of Air Force Engineering."[558] The Wing Commander of Phan Rang AB offered a similar evaluation of RED HORSE, stating that "The quality of work is not good, it is outstanding. As far as morale, esprit de corps, and the ability to respond rapidly to a combat support mission, RED HORSE must be rated with the best units in the Air Force."[559]

Personnel assigned to RED HORSE squadrons served for one year in-county and then were rotated back to the United States. By February 1967, 800 personnel were needed to replace the first two RED HORSE squadrons returning stateside. Replacement personnel also were required for squadrons formed later in 1966. Personnel initially assigned to RED HORSE squadrons represented some of the best and highly-skilled Air Force civil engineering personnel; it proved difficult to replace them with an equally skilled group. In 1966, Air Staff instructed TAC to create a training unit to handle 2,400 troops per year in order to keep the six RED HORSE squadrons stationed overseas staffed at the required manpower. The solution was the creation of the 560th RED HORSE Squadron, also known as Civil Engineering Field Activities Center (CEFAC), at Eglin AFB, Florida. Colonel Meredith temporarily took the role of commander of the center, until he was sent to South Vietnam. Col. Jack Rose became commander on October 1, 1967. Training was divided into two phases. Phase I, which lasted 30 days, served as an orientation with lectures on various topics including Southeast Asia, security, operations, and mobility. Phase II, which also was a 30-day program, provided field training. Phase II provided the troops with hands-on training including construction and the creation of infrastructure to prepare troops for real-life scenarios overseas.[560]

CEFAC also provided training for Prime BEEF troops and occasionally accommodated officers or non-commissioned officers who were not assigned to RED HORSE or Prime BEEF. CEFAC also coordinated training at alternate locations. In 1967, the editor for the *Air Force Civil Engineer* magazine, George K. Dimitroff, traveled to Eglin AFB, Florida, to observe RED HORSE training. Upon Dimitroff's arrival, Colonel Meredith advised him to undergo training, rather than just observe, in order to get a true sense of the program. Training included grenade launching as well as combat and maneuver techniques and simulated attacks. Dimitroff participated in the exercises for about two days, and was impressed by the quality and the spirit of the participants. "There is no doubt," Dimitroff wrote, "that they will continue to prove the motto of Air Force Civil Engineering - 'Can Do-Will Do.'"[561]

<u>Engineering Construction in South Vietnam</u>

At the start of the Vietnam Conflict, Air Force civil engineers encountered similar challenges to those faced during the Korean Conflict. The available airfields in South Vietnam were built by the French and Japanese during WWII and little had been done to upgrade the facilities for modern aircraft. Many older airfields were sinking into the water-logged soil or suffering from severe erosion.[562] An inventory of existing airfields in 1963 identified nearly 200 in South Vietnam and 39 in Thailand.[563] The Vietnamese terrain featured mountains and low, flat areas with high water tables. Air Force civil engineers also had to contend with the hot and humid summer climate; acclimation often took up to two weeks.[564] The weather provided challenges during construction and also accelerated the deterioration of facilities and runways.

Initial beddown facilities for Air Force personnel were tent encampments that provided the basic minimum facilities. Cantonment design followed AFM 88-15, *Emergency Construction Standards*.[565] As the deployment lengthened, more durable facilities were constructed for intermediate and long-term use. By 1966, MACV established common standards for U.S. military construction in South Vietnam, and identified three categories based on length of occupancy:

- Field for transient forces,
- Intermediate for between 24 and 48 months of occupancy, and
- Temporary for over 48 months of occupancy.

These categories of construction served as a guide to characterize the types of facilities constructed and their level of durability. After 1965, air bases typically were constructed for longer than 48 months of occupancy.[566] Construction in the contingency environment typically was of two types, troop cantonments and operations, i.e., the airfield and its supporting structures.

Base civil engineer squadrons in Vietnam typically followed the stateside organization and assumed the same responsibilities, such as operations and maintenance, firefighting, and environmental controls. Environmental controls included providing water, sewage, pest control, and refuse facilities. The major differences during deployment were the base civil engineer's role in construction and the expanded requirements for operation and maintenance in a challenging environment.[567]

At Bien Hoa AB, the base civil engineer supervised several facilities under construction. The projects at Bien Hoa totaled $6.3 million in 1965; by the following year, construction rose to $9.6 million. The 3d Civil Engineer Squadron comprised five officers and 112 Airmen. The base director of civil engineering at Bien Hoa, Lt. Col. Robert E. Maggart, supervised approximately 408 Vietnamese civilians who were hired to assist with construction. In a 1966 article in *Air Force Civil Engineer* magazine, Colonel Maggart remarked that "besides the language barrier we have to train them to understand heavy equipment, plumbing techniques and electrical wiring." By 1966, nearly 200 Vietnamese working at Bien Hoa had undergone full-time training. They attended a school managed by U.S. civilians with curriculum focused upon equipment use and handling.[568]

At Pleiku AB, the civil engineer operated in a similar work environment. The base civil engineer, Maj. Donald R. Reaves, commented on the increased workload at the air base, "when I got here 10 and a half months ago [in 1966] we had seven projects on the board. Now we have 140…in the states about 7 percent of the civil engineering workload is new construction or alteration, but here it's about 7 percent maintenance and 93 percent new construction." During a one-year period, the civil engineers at Pleiku AB, which comprised 84 military personnel and 128 Vietnamese workers, completed 145 structures totaling 130,000 square feet. Other construction projects included an airfield, roads, fencing, revetments, and a cantonment.[569] Engineers at bases such as Pleiku were also augmented by RED HORSE personnel who constructed wooden facilities used for offices, housing, or maintenance.[570]

Beddown

Initial troop beddown at many locations comprised Gray Eagle tents for troops and Bitterwine kits for operations. Gray Eagle kits, later called Harvest Eagle kits, included tents, mess equipment, and housekeeping supplies to support 1,100 men for a limited period of time. Bitterwine kits contained operational items.[571] The disadvantages of dark-colored tents were soon realized: the tents absorbed sunlight and were oppressively hot; the structures were poorly ventilated; and, tent fabric quickly deteriorated. Six months was the average life span for tents in South Vietnam.[572] Other problems with Gray Eagle kits were the reliance on the local economy for obtaining consumables and the lack of spare parts to repair equipment.[573]

A great diversity in facility construction resulted as base civil engineers, contractors, and other civil engineering personnel attempted to provide improved facilities for longer occupancy. Wooden huts with corrugated metal roofs, known as "hootches," were commonly constructed for housing troops. In mid-1966, MACV standardized the two-story hootch. Wooden buildings had problems of their own:

> Our sources of lumber were primarily local, that is, from Malaysia and Singapore. The mahogany which was obtained was for the most part green and dense, hard to nail, saw and work. If no structural section was available, the ripping into smaller sections entailed the burning of several saws before the necessary amount was cut. This hardwood was somewhat resistant to infestation; however, sooner or later succumbed to the attacks of powder post beetle borer, termite, dry rot or fungus. Lumber received from the regular supply channels whose shipment originated in the United States by the time it was utilized already exhibited evidence of infestation.[574]

Metal dorms were used for the first time at Tuy Hoa AB.[575] They satisfied the need for expedient troop and support housing and were generally well received. Complaints arose but tended to place blame on shipping by the manufacturer. On arrival at the base, spare parts were missing and construction materials were bent or damaged. At coastal locations, like Tuy Hoa, salt spray accelerated the deterioration of already damaged materials and required protective paint coatings.[576] Base civil engineer personnel at Phan Rang and Phu Cat ABs erected brick production facilities and were able to replace deteriorated buildings with permanent masonry construction.[577]

During the 1960s, the Air Force emphasized quick mobility and response. Funding during FY61 was directed towards design studies on relocatable facilities with the intent of deploying them in a theatre of operations. The new study was similar to the bare base concept, with an emphasis on substantial and durable relocatables.[578] In July 1969, Kimpo AB in South Korea was the first installation in a wartime operation to utilize the mobility concept. When additional forces at Kimpo AB needed to be accommodated, personnel with the 557th RED HORSE dismantled one 80-man dormitory at Kunsan AB, transported it, and then erected the dormitory at Kimpo AB, all within 18 days.[579] This operation helped prove the merit of the relocatable program.

Inflatable shelters, devised as a means to meet the needs of the rapid buildup of troops, were another option explored by Air Force personnel in Southeast Asia. AFLC managed the inflatable shelter program. Double-wall and single-wall inflatable shelters were manufactured from vinyl-coated nylon and inflated with small blowers. Once inflated, the semi-circular double wall shelters varied in dimensions from 48 by 60 feet to 48 by144 feet and the single wall shelters from 45 by 60 feet to 45 by 150 feet. Whereas the double-wall shelters maintained pressure between the walls, the single-wall shelters maintained air pressure in the entire shelter, necessitating air locks for access.[580] In 1965, 99 single-wall and 384 double-wall inflatable shelters covering six acres were in use in South Vietnam.[581] A preliminary report in 1969 stated that “heat is unbearable” inside the inflatable shelters. The report went on to add that the shelters were “good for only one purpose: keeping goods dry,” it was further recommended that canned goods not be stored in the shelters due to the buildup of pressure and potential for explosion.[582] Another complaint came from PACAF on February 5, 1966 when it requested permission from Headquarters U.S. Air Force to replace all inflatable shelters at Cam Ranh Bay AB. PACAF reported that the shelters were a complete failure; every inflatable shelter was deflated to some degree due to power failure and the failure of hand sealed cement joints in the fabric.[583]

Lt. Col. Francis E. Torr (right) and MSgt Bruce F. Swafford, members of Prime BEEF Team #1, measure AM-2 matting for use in aircraft revetments at Tan Son Nhut AB, South Vietnam, August 1965.

The use of prefabricated buildings and modular structures gained momentum later in the war. Pre-engineered metal buildings were useful to enclose large interior spaces. Procurement began in 1965 and, by 1968, 600 pre-engineered metal buildings were shipped and installed in Southeast Asia. The buildings were purchased as shells, with interiors added later. Although metal was prone to corrosion in the Vietnamese environment, protective paint prolonged its useful life. Modular construction was used for support facilities, such as hospitals and chapels. Modular facilities required only site preparation, external utilities, and foundations prior to installation.[584]

Operational Support

Airfields, comprising runways, taxiways, parking areas and operational support areas, were of critical maintenance priority for the base civil engineer. Airfield pavements also underwent a progression in contingency construction from temporary to permanent materials. Concrete containing Portland cement was the preferred surface for sustained operations of jet aircraft. However, asphalt was used in the majority of airfield construction due to its cost and ease of maintenance and repair.[585]

Initially, however, airfields were constructed using temporary materials. Use of PSP continued during the Vietnam Conflict despite the problems encountered during the Korean War. Other types of expedient runway materials were used as well: M8-A1; MX-19; and, T-17 membrane.[586] The T-17 membrane was designated for use with AM-2 matting.[587] Aluminum plank matting, AM-2, comprised interlocking aluminum mats 12 feet long, 2 feet wide, and 1½ inches thick. Each mat weighed 144 pounds. Sponsored by the Marine Corps Landing Force Development Activities, Marine Corps Schools, the AM-2 was developed as part of the Short Airfield for Tactical Support (SATS) Concept. SATS was a 2 to 3,000-foot long by 72 feet wide runway used for jet aircraft with arresting gear.[588] AM-2 was geared towards tactical operations of thirty days or less; the matting was moved to a new operational area when needed. AM-2 matting had only two requirements: a level surface and installation in a right-to-left pattern.[589] A concrete anchoring system was created to keep the AM-2 mats from moving once in place on the airfield. A trench, 12-feet in length, was dug on either side of the runway and graded. Concrete was poured into the trenches and then graded to the surface of the runway and PSP overrun. Proponents for the use of AM-2 cited its many advantages over Portland cement and bituminous concrete. By using AM-2, the need for concrete aggregate was eliminated. AM-2 also eliminated the need to construct facilities to mix cement and reduced equipment needs. Finally, AM-2 was expedient and saved time. The versatility of AM-2 allowed construction anywhere and manual installation also was possible, if needed.[590] Despite the ease of AM-2 matting, problems remained: "Since the joints in the mat are not waterproof…the water seeps through the joints and causes deterioration of the subgrade. To overcome this problem, a membrane of polyethylene reinforced with nylon yarn is being supplied for use under the mat. A number of membranes for this purpose are being tested."[591]

Concrete runways presented never-ending problems with regards to traction and cracking. On December 1, 1967, HQ PACAF demanded a survey and evaluation of all runways to assess pavement grooving options. Prior to the survey, Bien Hoa AB constructed grooved pavements to improve traction during wet conditions and air bases at Phan Rang, Phu Cat, and Tuy Hoa had a "rough 'broomed' surface" applied to the pavements to eliminate hydroplaning.[592]

Other airfield problems included improper preparation of the soil subbases. This deficiency led to continued maintenance problems. Cam Ranh Bay AB's airfields were constructed on a sandy subbase and consistently suffered from wind and rain erosion. Base civil engineers who maintained these airfields overcame the problem with routine drainage and runway maintenance. Despite their best efforts to install adequate drainage systems, monsoon seasons were challenging and several aircraft experienced hydroplaning on the airfields.[593] At Soc Trang airfield, civil engineers constructed dikes around the airfield and maintained two large Diesel-powered pumps to empty the trenches of water over the sides of the dikes, thus draining the entire complex.[594]

Utilities

Potable water and sewage systems were great concerns to base civil engineers. The majority of air bases were constructed in barren areas, which necessitated the construction of water and sewage systems. Water sources in Vietnam were polluted and easy targets for the Viet Cong. For those reasons, base civil engineers purified ground water to supply base needs. Sewage systems typically combined septic tanks and leaching fields. However, these systems were vulnerable during monsoon seasons when the water table rose; base civil engineers faced the challenge of heightened health hazards.[595] For the air bases located within the delta region of Vietnam, wells often were drilled to depths of 500 feet. Elsewhere in Vietnam, civil engineers drilled through bedrock before reaching water. Lack of modern well-drilling equipment added stress and created additional work for civil engineering personnel.[596] By 1973, civil engineers had drilled more than 300 wells in Vietnam.

Another major issue in constructing and maintaining the air bases was electrical power supply and distribution. Electrical power was a critical base support element in Southeast Asia. The Air Force mission required large amounts of electricity to power communications systems, airfield lighting, modern weapons systems, computers, operations and cantonment lighting, refrigeration, and air conditioning units. The commercial power supply available in South Vietnam was limited and unreliable; the local current was not compatible with Air Force requirements. The Air Force installed electrical generation equipment and systems at all bases it occupied. In 1965, only electric generators of low voltage were available and most of the generators were not designed for continuous service. To overcome the shortage of power generation equipment, PACAF sent everything that could be spared. By July 1965, 62 portable generators representing 16 different models were installed at 23 locations on Tan Son Nhut AB. Obtaining spare parts to keep the equipment running was a "significant limitation." Servicing a variety of types of generators taxed the skills of power production professionals. Beginning in 1964, PACAF initiated a program to install central primary power plants and distribution systems at each base. However, even with this plan, the demand for electrical power often rose beyond the capacity of the equipment and the electrical power systems required continuous upgrades.[597]

Force Protection

During the buildup in 1964 and 1965, the three primary air bases, Tan Son Nhut, Bien Hoa, and Da Nang, quickly exceeded personnel and aircraft capacity. Available parking space for aircraft was not sufficient, so that aircraft were parked close together. The need for aircraft revetments and protective shelters was clearly seen after the Bien Hoa AB accident on May 16, 1965,[598] in which an explosion on base destroyed 40 aircraft, wounded 100 and killed 28 Americans, including four explosive ordnance disposal personnel. MSgt George J. Frank, stationed at Bien Hoa, described "heavy chunks of shrapnel and aircraft parts began raining on the parking ramp" after the initial explosion. Secondary explosions continued throughout the day. Sergeant Frank remembered,

> The B-57 parking area was a mass of twisted metal, bomb craters, and rubble. The area where the fuel bladders had been was nothing but scorched blackened earth. I vaguely remember removing a body from the rubble and carrying it to a stretcher, and when I laid it on the stretcher I realized it was one of the guys from my "hooch" and that he was dead.[599]

On August 24, 1965, an additional 45 aircraft at Bien Hoa were damaged by mortar attack.[600]

The first three Prime BEEF teams were deployed to Vietnam to assist in the revetment program. The standard revetment used to protect aircraft during the war was the ARMCO steel bin constructed of heavy corrugated steel. Walls were set 5.5 feet apart and filled with compacted soil. The revetment

It worked! The revetment at Da Nang AB received a direct hit from a 122mm rocket during a Viet Cong attack on the base in January 1968.

stood 12 feet high. The first Prime BEEF teams arrived before the revetment kits and immediately began stockpiling soil. Eventually, the first three teams erected 45 revetments, over 12,000 linear feet, during the 120-day deployment.[601]

Pre-cast concrete slabs were used at Da Nang AB to protect personnel facilities, vehicles, and equipment. Each slab measured 10 x 4 feet by 5 -5/8 inches. Pre-cast concrete slabs were less expensive overall and required less manpower to install. In addition, the slabs were relocatable and allowed design flexibility for base civil engineers.[602]

Another critical construction program in South Vietnam was the TABVEE hardened aircraft shelters for aircraft protection. General Meredith, who was working with deployed RED HORSE squadrons at that time, recalled his experiences with building TABVEE shelters at Da Nang AB:

> Col. Jim Bowers stopped in and asked if I would go up to Da Nang, take some of my troops and start the first shelter program. I had three detachments at that time. So I did. But we found some flaws in it, and John Peters was back at the Pentagon designing those things. I contacted him and told him the damn thing didn't fit. We had a lot of guff back and forth. Finally, I just shut down the radio lines and told the boys, "Let's put this thing together. If we have to drill another hole in it, we will." The formation of those things was such that the alignment was very critical. If in shipment they dropped them or sprung them the least bit, you had a half hole in the whole damn section of the thing. You'd sit there and fight it with a gagling pin, trying to get it lined up. I said, "To hell with that. Take a drill over there and drill a

(above) Bien Hoa AB firefighters don their suits to respond to an emergency call.
(below) Fire trucks at Pleiku AB stand ready to respond.

> hole beside it and put the bolt in." One of the sergeants looked at me and said, "But it'll leak through that hole." I said, "You're pouring 18 inches of concrete on top of it, so who in the hell cares."[603]

The aircraft shelters quickly paid for their construction costs; $7.8 million worth of aircraft stationed in South Vietnam was saved in 1969. This cost savings amounted to nearly 50 percent of the total shelter program.[604] Earlier that year, an aircraft shelter at Da Nang AB was struck with a 140 mm rocket. The shelter sustained minor damage while the $2 million F-4 aircraft was unharmed.[605] Although the early shelter program satisfied immediate needs, several difficulties arose with the design. The most pressing problem was the lack of lights and power outlets. Due to the lack of ventilation and insulation, troops worked on aircraft outside of the shelters and exposed themselves to attack. Water leaks through ceiling cracks in the concrete often were reported as well.[606]

Firefighting

Fire protection in South Vietnam was the busiest fire protection organization in the world. The Seventh Air Force Command Civil Engineer was responsible for fire protection in Vietnam. The Fire Protection Branch in the directorate was staffed by a chief master sergeant with a technical sergeant as an assistant. In April 1966, fire protection services comprised 313 personnel and 90 vehicles to support eight active bases. Available vehicles included the P-2 aircraft fire rescue vehicle and the F-7 water tanker. It was typical for firefighters to work 18 to 20 hour days responding to emergency calls on and off base, maintaining runway and ramp patrols, and dispersing equipment. Within the combat zone, equipment was dispersed at night to protect it from mortar attacks and small arms fire. At some locations, fire protection personnel were armed with M-16 rifles.[607]

At the start of the Vietnam conflict, the fire departments typically occupied tents for both personnel and equipment. Personnel constructed new buildings and rebuilt old facilities through a self-help program. By April 1967, the number of U.S. Air Force firefighters increased to 456 and 109 vehicles to provide fire protection on 10 bases. Firefighters responded to 42,570 emergency calls and maintained 57,701 hours of ramp and runway patrols during the first half of 1967. Fire departments also wrote fire prevention regulations, and set up and serviced water barrels and fire pails until sufficient fire extinguishers were available.[608]

While serving in Vietnam, fire chiefs trained their Vietnamese counterparts in fire protection. However, the hectic pace of emergency responses decreased the amount of time available for fire chiefs and personnel to train Vietnamese firefighters. The U.S. Air Force established a training program at Nha Trang AB headed by MSgt. William Bell.[609] Air Force fire services also activated airborne units during the Vietnam Conflict. The HH-43 PEDRO helicopters were able to respond to emergencies in remote areas far quicker than the ground forces. Each PEDRO was equipped with a fire suppression kit that held 78.5 gallons of expellant and 150-feet of hose. As the military began to withdraw troops from Vietnam, the Air Force began inactivating PEDRO units with the last unit inactivated in 1975.[610]

New Air Bases

As military requirements grew, the Air Force ordered the construction of five new air bases—four in South Vietnam and one in Thailand. Bin Thuy, Phan Rang, Cam Ranh Bay, and Phu Cat were developed in Vietnam and Sattahip (U Tapoa AB) was chosen in Thailand. The sites selected for the new air bases in South Vietnam typically were near the coast to ensure security and logistic support by water. Sites were selected after map analysis, aerial reconnaissance, and ground reconnaissance survey. If the site had potential, a feasibility study was conducted that included a topographical survey of potential locations for runways, availability of real estate, flight hazards, drainage, water sources, availability of construction materials, and local labor. Final site selection occurred after a full topographic study. The typical new air base required between 4,500 and 7,500 acres.[611]

Construction of each airfield was completed in two phases to gain operational status as rapidly as possible. Phase I provided interim facilities and an expedient runway; Phase II supplied a Portland cement runway as well as permanent housing, support, and maintenance facilities.[612] The four new bases initially were staffed by one civil engineer officer and a few enlisted personnel to oversee power production, fire protection services, and construction contractors.

The arrival of Red HORSE squadrons alleviated pressure on the contractors for Air Force construction. The 554th CES (HR) began work at Phan Rang AB with the replacement of much of the deteriorated runways and soil subbases. While the 554th repaired the airfields at night, base operations continued without interruption during the day. Additional work at Phan Rang AB included the construction of aircraft shelters; maintenance and supply facilities; and runway arresting barriers.[613] Meanwhile, the 555th CES (HR) deployed to Cam Ranh Bay AB and constructed over 100 buildings. Phu Cat AB utilized the services of the 819th CES (HR) to complete the base while contractor RMK-BRJ worked on the airfield. The MCP for South Vietnam had exceeded the allocated funds for RMK-BRJ, therefore, the Air Force relied heavily on RED HORSE units to complete its new air bases.[614]

Phan Rang AB in Vietnam became fully operational on March 14, 1966, one day ahead of schedule. Construction on the base had begun the previous September by the U.S. Army Corps of Engineer's Company D, 62d Engineer Battalion.[615] Runways constructed at Phan Rang AB were identical to those at Cam Ranh Bay AB. The runway at Cam Ranh Bay AB was 10,000-feet long by 102-feet wide and constructed with AM-2 matting.[616]

Project Turnkey: Tuy Hoa

The Air Force identified the need for a fifth air base in 1965. After several months of discussion between the Secretary of the Air Force, Joint Chiefs of Staff, CINCPACAF, and other high-level officials, Secretary of Defense McNamara endorsed the Tuy Hoa site and to allow the Air Force to serve as construction agent.[617] Maj. Gen. Guy H. Goddard explained, "Priorities were tight, and the Air Force needed a fighter base."[618] However, the Navy OICC and its contractor RMK/BRJ were so inundated with projects that completion of Tuy Hoa was problematic. Navy OICC personnel "jokingly"

Col. Archie S. Mayes chairs a meeting on construction progress at Tuy Hoa. Left to right are Col. John Peters, Lt. Col. Don Woods, Col. Mayes, and Col. Harvey Latson.

The site selected for the new air base was along the South China Sea coastline, near the village of Tuy Hoa. The site was chosen so equipment and supplies could be brought in "over the beach."

proposed that the Air Force find their own contractor, and the Air Force obliged.[619] Constructed by the Air Force, Tuy Hoa AB was the only Air Force base constructed in Vietnam that was completed on schedule and within budget.[620]

The Air Force selected the turnkey approach. Using the turnkey process, a contractor designed and constructed the project, then turned the keys over to the client. Secretary of the Air Force, Harold Brown, approached Secretary of Defense Robert McNamara with the concept on February 8, 1966.[621] Lt. Gen. Joseph H. Moore, 7th Air Force Commander, and Brigadier General (then Colonel) Mayes approached MACV with the turnkey concept. Project Turnkey's goal was to provide the Air Force with a combat operational base in a minimum amount of time and solely contracted by the Air Force. After much haranguing by the Army Generals and Navy Admirals, the Air Force's proposal was finally approved in May 1966 on the conditions that all material and equipment be brought over the beach; that construction would have no impact upon the logistics and construction systems already in place; and, that the project would be completely contracted by the Air Force.[622] Tuy Hoa AB was required to be operational by December 1966 and fully completed by the end of June 1967.[623] Throughout the construction of Tuy Hoa, Secretary Brown maintained an avid interest in Project Turnkey. He requested weekly status reports that included every project detail, from material shipped and received to percentage of construction completed.[624]

Planning and management of Tuy Hoa was a highly efficient organization with operations located in Washington, D.C., New York City, Hawaii, Saigon, and Tuy Hoa. At the Air Staff level, Brig. Gen. Guy H. Goddard managed the project. At HQ PACAF, the Turnkey contract (TKC) office was headed by Col. Henry (Fritz) Stehling; the Program Director's office (TKC-1) was at HQ 7th Air Force in

A bulldozer levels the beach as a landing craft approaches bringing in equipment and supplies for the buildup of Tuy Hoa.

Saigon with Col. Archie Mayes, Director of Civil Engineering and Col. John D. Peters. The New York City project office, designated as TKC-2, was led by Col. Harvey Latson and supported by personnel from the AFRCE South Atlantic Region office. Tuy Hoa AB was designated as TKC-3 and Col. David S. Chamberlain served as the Turnkey Resident Engineer.[625] Altogether, Project Turnkey had approximately 50 Air Force personnel in four locations ensuring the success of the effort. Colonel Chamberlain oversaw a workforce of 30 military personnel, 725 contractor U.S. civilian employees, 300 Filipino contract stevedores, and 700 contract Vietnamese employees.[626]

The targeted location for this endeavor was along the coast of Vietnam at Tuy Hoa. The contract was awarded to Walter Kidde Constructors, Inc., and signed on May 31, 1966, four days after the official acceptance by the DoD. The new base had to be operational by December 1966.[627] Kidde subcontracted with McCormick and Sons, who specialized in earth-moving projects. The contract between Kidde and the Air Force had several provisions and unique clauses relating to the site, construction, and payment. The contractor was required to "handle all procurement within the United States," to provide all transportation and receiving services, as well as to erect "a protected unloading site." In addition, construction labor was restricted to local nationals near Tuy Hoa and U.S. workers; equipment and materials could only be shipped from the East Coast and Gulf ports; and, U.S. employees were mandated to avoid local politics and minimize impact on the culture and economy of Tuy Hoa.[628] As a precaution, construction personnel received five percent of their wages in military scrip in-country; the balance of their wages was received upon their return to the United States.[629]

The Air Force issued a cost-plus, fixed-fee contract, estimated at $52 million, to complete Tuy Hoa AB.[630] As a way to minimize additional construction expenses, the Air Force developed a construction schedule and demobilization schedule. All construction tasks for Tuy Hoa AB were assigned a completion date and followed a sequential order applying the Critical Path Method. As the project came to a close, the contractor was to decrease the number the workers commensurate with the outstanding work in accordance with the demobilization schedule. Adherence to these schedules resulted in bonuses for workers and contractors. However, a ten percent late fee would be charged if construction was completed past the due date.[631] A morality clause was another unique requirement of the contract; additional bonuses were awarded for maintaining alcohol and problem-free construction sites. [632] All of the clauses relating to bonuses followed the 'all or nothing' approach. "Come hell or high water, no matter what it was, if they didn't finish it on that date they didn't get paid the bonus, and they made every one of them," said General Peters.[633] General Mayes later reflected, "All of these things—morality clause, completion schedule, and a strict demobilization schedule—contributed to the successful completion of that very unique contract."[634]

Air Force officials provided Kidde with the Navy's blueprints for Vietnam construction. After choosing the best designs, Kidde adapted them to site conditions at Tuy Hoa.[635] No port facilities were available at Tuy Hoa at the start of construction. The site location for the air base was a bare beach when the construction crews arrived.

The first 30-man contractor team arrived at Tuy Hoa in June 1966. Except for the 101st Airborne Division's tents encamped at the existing Vietnamese asphalt airstrip known as Tuy Hoa South, the 4,340-acre site was empty.[636] The first shipment of tools, materials, and equipment arrived August 11, 1966.[637] The Air Force and contractors delivered materials and supplies by the "invasion/assault method," which utilized lighters (open, flat-bottomed barges) and landing craft to convey the material and equipment from the cargo ship onto the beach near the construction site.[638] Kidde had subcontracted the use of lighters and landing craft, which were predominantly reconditioned World War II-era vessels.[639]

The base master plan was extremely detailed and prohibited the construction of temporary contractor facilities. All construction, including roads, was specified to be compatible with base operations, hence the motto at Tuy Hoa: "Do It Once, Do It Right;" General Peters added,

> We decided that if we were going to build a base there we weren't going to let contractors run all over the place building all kinds of construction roads that were going to waste a lot of time. The first decision we made was that all the construction roads would eventually be streets, so that we didn't build streets that we'd never use again.[640]

All buildings erected at the site were designed to become Air Force facilities on the completed base. Air conditioned modular housing was purchased in Australia and sited for use later by Air Force personnel.[641] The contractor morgue later became the base computer facility.[642] Meanwhile Air Force personnel erected Gray Eagle harvest kits and lived in tents, some for as long as eight months.[643] As in the case of Phu Cat, Cam Ranh Bay, and Phan Rang, airfield construction at Tuy Hoa was executed in two phases. The first phase quickly established interim runways and facilities while the second phase developed permanent airstrips and additional facilities. Construction initially focused on completing the 9,000-foot AM-2 matting runway as quickly as possible so that flight operations could begin. Simultaneous construction included a parking apron, bladder system for petroleum storage, and dormitories for Air Force personnel.

As construction progressed, inevitable problems and obstacles arose. The Air Force answered these challenges with innovative solutions and hard work. Although there was a plan to expand the existing 3,000-foot Vietnamese runway for use by larger aircraft, the Air Force opted to construct an entirely new runway because, according to General Mayes, "Well, we had to do the runway anyway. Why waste time extending a very substandard existing runway?"[644] As General Peters explained,

> There was a 3,000-foot runway at Tuy Hoa that was already there. The plans said to extend it to 6,000 feet. When we got out there and looked at it, I said, "You know what? We need to look at this." Because where the new runway was going—the temporary one—looked to me as though it would take a helluva lot less grading and

> would require a lot less material to be brought in than where we were. So, we ran a centerline on both of them and enough traverse points to get a pretty good hook on how much material was required. It turned out that we could have the damn new runway built before we ever got the other one to where we could even think about putting anything on it. [Col.] Archie [Mayes] and I commiserated over that for about a week because we were going to do something that they didn't tell us they wanted done. We made up our minds we were going to do that. I made all the calculations and showed how much less earthwork was to be done and how fast we could do it. We sent a TWX [joint message form] back [to the Pentagon] and told them that was what we were going to do and why. We were supposed to make that other one the temporary runway with aluminum mat. We got a TWX back that said, "Maj. Gen. [Guy] Goddard and [Deputy Assistant Secretary of the Air Force] Lew Turner are coming out," and they told us the date. I said, "We're going to have 5,000 feet of runway for them to land on."[645]

The AM-2 runway was completed on November 12, 1966, six weeks ahead of schedule. Three days later, aircraft from the 308th Tactical Fighter Squadron landed at Tuy Hoa.[646]

Construction on the permanent, 9,500-foot concrete runway was the second priority and posed another challenge: creating a 10-inch reinforced concrete runway with the supplied 13-inch forms. A mistake in the delivered supplies led to several trial attempts to lay 10-inches of concrete with the 13-inch forms. Finally, Colonels Mayes and Peters decided that it would be cheaper, quicker, and easier to build a 13-inch runway with a larger aggregate rather than find a way to use 10-inches of concrete in a 13-inch form. The concrete runway was finished on April 6, 1967, a full month ahead of schedule. Additional challenges included unloading equipment and supplies during a typhoon, and repairing the Vietnamese railroad to provide access to quarries and concrete plants. General Mayes later explained how the need for housing was addressed,

Maj. Charles Lamb (left) and Maj. Edwin (Doug) Reinhardt monitor the progress on the initial runway at Tuy Hoa.

Members of the 820th RED HORSE Squadron level a site in preparation for the construction of a maintenance apron at Tuy Hoa.

> When they were figuring in New York about buying construction material, someone found out that there was a standard building that was sold for chicken coops. So they went to the manufacturer and he modified the building to put a special kind of louvers on the sides and the kind of ends we wanted. They bought those knocked down in large volume, so what we put up for barracks were actually modified chicken coops. They were real good barracks.[647]

On June 10, 1967, construction facilities and airfields were completed two weeks ahead of schedule and consisted of a 4,000-man cantonment area; two jet runways; parking aprons; O&M facilities; POL storage; and, a physical plant.[648] By completing the ambitious project in 210 days, Project Turnkey saved the Air Force an estimated one million dollars.[649]

The first Air Force unit to arrive at Tuy Hoa in October 1966 was the 820th CES (HR) squadron

Assistant Secretary of the Air Force Lewis Turner (left) and Lt. Col. Hubert "Hub" Johnson tour Tuy Hoa AB during an update visit with Col. Archie S. Mayes.

under Col. Waldo Potter. This RED HORSE unit began stateside training in July 1966 and was deployed to Tuy Hoa, but not as part of Project Turnkey.[650] The missions for the air base had grown, nearly doubling the amount of aircraft deployed to the base. RED HORSE continued construction of a concrete runway, concrete taxiway, apron enlargements, revetments, aircraft shelters, warehousing facilities, cold storage facilities, 53 dormitories, and other support buildings.[651] Construction continued through mid-June 1967 when the base was considered complete and fully operational. Approximately 50 percent of all construction at Tuy Hoa was completed by the 820th CES (HR).[652] After the contractors left, all of the equipment was turned over to the RED HORSE squadrons. The 820th CES (HR) remained stationed at Tuy Hoa AB until 1969.[653] In all, two rotations, totaling 800 RED HORSE personnel, served at Tuy Hoa AB.[654] Although not under the command of the base commander, RED HORSE personnel worked in tandem with the base civil engineer squadron. The base CES also erected additional buildings to support operations such as maintenance shops and smaller construction projects, including four inflatable shelters.[655]

The achievements of many of the leading personnel involved with Tuy Hoa were recognized through promotions. Then Colonels Archie Mayes, Dave Chamberlain, Henry “Fritz” Stehling, and John Peters, all advanced to brigadier generals.[656] Colonel Chamberlain became the Deputy Chief of Staff for Civil Engineering at TAC and PACAF.[657] Capt. Gary Flora served for a year in the base civil engineer squadron during the base construction; he later served as The Air Force Civil Engineer in 1992. Other personnel associated with Tuy Hoa were Maj. Charlie Lamb, who later became a brigadier general and Capt. Frank. A. DeMartino, who was later promoted to colonel and became a major command civil engineer. Brig. Gen. Archie S. Mayes summed up the Turnkey Project at Tuy Hoa,

> I believe that Project Turnkey can only be categorized as a resounding success. First, it provided much-needed fighter aircraft at an early date for the overall commander in Vietnam, that is, General Westmoreland. Moreover, it demonstrated to all the services that Air Force Civil Engineering had come of age and was fully capable of building an Air Force base on its own. It also brought on lessons for the future, that is, that in any future major undertaking involving all the services, the Air Force could be expected to step forward and do whatever part is assigned to them with full engineering competence.[658]

U.S.S. Pueblo Crisis and Buildup of Forces in South Korea, 1968

At the height of the Vietnam Conflict, an incident occurred that increased tensions in the Korean peninsula. On January 23, 1968, North Korea seized the *U.S.S. Pueblo,* a U.S. naval intelligence gathering ship, on the pretext that it was within territorial waters, a claim denied by the United States. At about the same time, an assassination attempt on South Korean President Park Chung-hee was traced to North Korean agents.

The United States responded to these incidents with a rapid buildup of U.S. forces in South Korea. Several fighter squadrons were deployed to South Korea to augment the Fifth Air Force headquartered in Seoul. The U.S. Air Force had existing civil engineering squadrons and facilities at Osan and Kunsan ABs and limited facilities at Kimpo AB. Little had been done to these bases since their use during the Korean Conflict. At Kunsan, the undermanned 6175th CES worked around the clock to deal with the 500 percent increase in personnel at the base. South Korea made additional facilities available at three South Korean air bases: Kwang-ju, Taegu, and Suwon, but these bases required substantial upgrading.[659]

The existing civil engineer squadrons could not support increased operations, so Prime BEEF teams were deployed. The first Prime BEEF team was assembled from PACAF civil engineers and was followed by nine Prime BEEF teams dispatched from CONUS bases. General Mayes, then the Deputy Chief of Staff for Civil Engineering at HQ PACAF, told this story,

557th RED HORSE Squadron Emblem (Courtesy of Mr. Jim Pennino).

> It was below zero and the airplanes were arriving [in South Korea]. I was talking to General Curtin on the phone and he said, "I've got eight Prime BEEF teams heading that way." They loaded those Prime BEEF people up on airplanes and got them over there. They hit the ground running and built hard-backed tents and everything. We didn't have enough quarters and floor space to bed people down. We had them stacked everywhere.
>
> We put in tents and heaters in the tents. They did it with those Prime BEEF teams. In the meantime, he [General Curtin] called me and said, "I've got another RED HORSE squadron being organized." That was the 557th. They wanted to permanentize a lot of facilities because they thought it was going to be a long duration deal in Korea. In the meantime, we made one of our famous bills of materials, as best we could, and ordered another million dollars of material. AFLC bought the stuff and put it on a ship. About the time the RED HORSE squadron hit Osan, the ship arrived at Seoul. They went down and met the ship so we wouldn't lose any of our stuff. They unloaded it and used it to start putting in decent permanent facilities.[660]

The U.S. Army Corps of Engineers served as the construction agent for the construction program during the buildup in South Korea, and 60 percent of the program was devoted to Army facilities. Prime BEEF teams and the 557th RED HORSE squadron, which arrived in April 1968, supported immediate Air Force requirements, while contractors were employed for long-term projects and to support base operations and maintenance. The first task was to bed down incoming Airmen in temporary facilities. Airmen were housed in air base community buildings, in tents, and in facilities provided by South Korea. Harvest Eagle kits were erected and comprised primarily tents that were adaptable to many uses. During the first Prime BEEF teams' 90-day TDY, they erected nearly 1,000 tents, dug wells, constructed wood-frame buildings, laid airfield matting, installed aircraft arresting barriers, upgraded utility systems, and installed sandbag bunkers.[661]

With the arrival of the RED HORSE squadron in April 1968, more permanent facilities were constructed, including revetments, and modular dormitories. RED HORSE personnel were assigned for 179 days TDY. This was because of a roles and mission dispute with the Army. The resolution was that the 400-man team deployed as a quasi-squadron because the Army would not agree to the deployment of a squadron, but would agree to a 400-man BCE augmentation unit. At the end of that period, the Army relented and the squadron was reassigned to Fifth Air Force and staffed by permanent change of station (PCS) replacement personnel.[662] RED HORSE began the construction of permanent facilities, including pre-engineered steel buildings, revetments for aircraft and ammunition, aircraft maintenance shops, and other facilities. PCS RED HORSE personnel who arrived late in 1968, erected modular relocatable dormitories, as well as constructed hardened aircraft shelters to protect approximately 170 tactical aircraft. Various other types of facilities also were built, including communications and operations facilities, taxiways, airfield pavements, and fuel and ammunition storage buildings. Much of this work was accomplished in the winter. General Mayes, then the Deputy Chief of Staff for Civil Engineering at PACAF, wrote to Col. Winston H. Clisham, 557th Commander, "I was particularly impressed during my February visit to see the aircraft shelter program underway. I can think of no more distasteful task than working on those 'beasts' in sub-zero weather, but nevertheless your squadron did so and quite successfully."[663] In addition, the Air Force civil engineering squadrons erected prefabricated metal barracks to house approximately 6,150 troops. More than 70 percent of the construction, which was financed through a supplemental military construction appropriation in 1968 and through subsequent appropriations, was completed by the end of FY71.[664]

An example of the efficiency of the Prime BEEF in Korea was recounted by Maj. Gen. Robert H. Curtin. He appointed Col. George Andrews, a Vietnam veteran, to oversee the Prime BEEF teams, which were being sent to South Korea on short notice. When General Curtin arrived in Korea six days after Colonel Andrews, he began hearing complaints about Colonel Andrews. As General Curtin told the story:

> I said, "You've got to have a good case. I'm not taking him [Colonel Andrews] out. What's the case?" They said, "Well, he has all the taxicabs in Seoul under his control." I said, "What happened?" They said, "We don't know." I went to see George and he said, "Yes, I've got them under my control. I've got them carrying cement out to repair the air bases. I asked the Army and Navy for trucks and nobody would give me any. That's the only way I could get the cement, and you told me to get the job done." I said, "George, I support you." He had them all, every one of them lined up. I left him there, and he was happy. God, it was cold! That was in February, as I recall. That was the sort of guys we had, too. Nothing was too big. "Let's go," they'd say.[665]

Drawdown from Southeast Asia

President Richard M. Nixon initiated the steps that led to the U.S. withdrawal from South Vietnam. During the election of 1968, Nixon promised to withdraw U.S. troops with "peace and honor." In June 1969, he announced the beginning of troop withdrawals from South Vietnam. By August 1972, U.S. military personnel in Vietnam numbered 40,000.[666]

Although the Nixon administration was involved in peace negotiations in the early 1970s and began turning over bases and equipment to the South Vietnamese, the United States escalated bombing of strategic targets in North Vietnam under code name LINEBACKER I and II, and secretly bombed Cambodia. The bombing campaigns appeared to contradict Nixon's pledge to end the war, but in reality, the United States made progress toward a peaceful solution.[667] The Nixon administration negotiated a cease fire that began January 29, 1973. The agreement established the border between South and North Vietnam, pledged the withdrawal of the last U.S. combat forces, and returned U.S. prisoners of war. The United States withdrew its remaining combat forces in 1973, repositioning some Air Force personnel to Thailand. Two years later, North Vietnamese forces initiated a military offensive that resulted in the collapse of the South Vietnamese government. The Air Force participated in the dramatic airlift of the remaining U.S. support personnel and thousands of South Vietnamese refugees during April 1975. The country was unified under a Communist government, and the People's Democratic Republic of Vietnam was declared in July 1976.[668]

Before leaving South Vietnam in 1973, Air Force civil engineers, primarily RED HORSE, were involved in removing and salvaging materials from the bases. General Meredith and General Mayes worked together to salvage as much of the AM-2 matting from the bases as possible. Aluminum was a potential valuable commodity for countries like China. Troops pulled up the matting and shipped it to PACAF. The salvaged matting was returned to the factory for recycling into new AM-2, which was then stockpiled in different parts of the world. As much heavy equipment as could be stowed was placed abroad the ships transporting the matting.[669] Relocatable buildings and modular dormitories were moved to Thailand and South Korea.[670]

The 554th served at several bases in South Vietnam (Phan Rang, 1965-1969; Cam Ranh Bay 1969-1971, and Da Nang 1971-1972) and left for U-Tapao AB, Thailand in June 1972 to continue its work. The squadron divided into several detachments in 1973 and 1974 (Osan AB, Korea; Clark AB, Philippines; Kadena AB, Japan; Ubon Royal Thai Air Force Base (RTAFB); and Nakhon Phanom RTAFB). The men at the Thai bases performed heavy repair work, security enhancements, and small construction projects. They also conducted retrograde operations on modular buildings by dismantling and preparing them for shipment. They disassembled, cleaned, and packaged 131,000 square feet of AM-2 matting at Nakhon Phanom RTAFB. The detachment at Clark AB repaired dormitories, altered a warehouse, and constructed maintenance shop buildings. In early 1976, the 554th moved to Osan AB, Korea.[671]

Some Air Force civil engineers assigned to PACAF remained as advisors to the South Vietnamese Air Force after the majority of U.S. troops were withdrawn. These military and civilian advisors evacuated when Saigon fell to the North Vietnamese. Air Force civil engineers left the country on the night that Saigon fell on whatever transport they could secure. Evacuation routes varied. Some personnel arrived in the Philippines and others made for destinations all over the Pacific theater. It took some personnel 15-20 days to reach a location where they could report back to PACAF.[672]

The contingency operations in Vietnam provided a wide variety of lessons learned for Air Force civil engineers, as well as for the entire Air Force. In 1966, the Air Force directed the Air University to "evaluate the effectiveness of all elements of the employment of air power in Southeast Asia since 1954." The Corona Harvest project was initiated to assemble data and to record lessons learned. Lessons learned relevant to civil engineering were assembled by the Civil Engineering School at Wright-Patterson AFB, Ohio.[673]

Air Force civil engineering was advanced from the experiences in Vietnam in many areas, including research and development, contingency planning, staffing and deployment, construction programming, and facilities construction. One area of particular importance was in the further development of the bare base concept and the refinement of expeditionary packages to support quick troop deployment. Tactical air units often arrived in the theater of operations before support facilities. Gray Eagle kits used early in the Vietnam Conflict comprised surplus equipment from World War II and Korean War that were prepositioned in the Pacific Theater. The kits were designed to provide the bare essential support for operations until permanent equipment arrived.[674] The kits were "bulky, heavy, and required" a number of Airmen to maneuver the equipment.[675] Kits were not completely air-transportable which caused delays while components were transported by sea. In many cases, Air Force personnel's first experience with the Gray Eagle Kits was upon arrival at the deployment site.[676] During the mid-1960s, additional equipment was incorporated into the kits while other supplies were redesigned. These revised kits became known as Harvest Eagle kits. Harvest kits were designed to support 1,100 persons for 30 days and contained "flimsy shelters" requiring constant maintenance and repair.[677]

In 1966, the Bare Base Task Force was established at Headquarters, Aeronautical Systems Division with the mission to improve the mobility of tactical fighter wings. The Task Force evaluated the current functions and performance capabilities of the wings and compiled recommendations in the TAC Enhancement Study dated December 1966. The study confirmed that improvements were necessary and identified 71 areas to improve the wing's response time.[678] At the same time, the Air

Staff was developing a related concept and published AFM 2-40, *Operational Concepts and Capability Standards for Mobility, Austere Basing and Support of Tactical Air Forces* in November 1967.[679] Based on lessons learned during Vietnam and information from the Bare Base Task Force, AFM 2-40 established five criteria for mobile equipment: functional, as light weight as possible, completely air-transportable by C-130s, easily operated with minimal training, and durable.[680]

The studies completed by the Air Force identified a need for the development of a mobile unit with the "capability to deploy to an isolated, nonfunctioning airstrip" or a bare base.[681] To be defined as a bare base, the locale had to include a "runway, taxiway, parking ramps and a source of fresh water."[682] Prepositioned kits provided deployed units with essential equipment for construction of facilities.

Bare Base Mobility, Project 3782, contained the equipment and facilities identified in prior studies. The equipment included barracks, dining halls, hangars, communications centers, dispensaries, and maintenance shops, as well as electrical generators, utilities, bomb damage repair system, crash removal equipment, and air transportable runway construction equipment. Bare base equipment was designed as modular aluminum and plastic sandwich structures. The outer shells of the structures served as the containers for storage and shipping. Once deployed, the packages were expandable and required a few hours to install.[683]

A demonstration of bare base capabilities, Coronet Bare, was held October 1969 at North Field, South Carolina. The exercise was successful and showcased "air transportable expandable maintenance and hangar facilities, individual power and water distribution systems, and other new mobility equipment that converted the bare base landing strip into a functional operating base."[684] Commenting on the success of the demonstration, Gen. William W. Momyer, TAC commander, noted, "This demonstration will long be remembered as a key step toward obtaining truly lightweight, air-transportable mobility equipment so badly needed to support our modern strike forces. The effectiveness of this new equipment, validated by the North Field demonstration, has signaled a new era in tactical air mobility."[685]

Maintaining Prime BEEF teams' and RED HORSE squadrons' ability to respond to emergencies or contingencies was another area of important lessons learned. The drawdown after Vietnam brought pressures to reduce military personnel numbers and budgets. The valuable contributions of Prime BEEF and RED HORSE during the conflict were recognized by those who served in Southeast Asia. Lt. Gen. Francis C. Gideon, 13th Air Force Commander, wrote in 1969, "Retention of Civil Engineer heavy repair squadrons (RED HORSE) in our force structure is a matter of great importance."[686] Opinion was divided among Air Force civil engineers as to the importance of Prime BEEF and RED HORSE in the peacetime Air Force. Prime BEEF was enmeshed with the base-level Air Force civil engineering structure and played a role in base recovery plans. RED HORSE squadrons, however, were separate units with their own organizational structure. Some operational commanders, such as Generals Meredith and Mayes, worked to retain RED HORSE squadrons at a reduced level. General Meredith, in particular, was concerned about the future of RED HORSE squadrons. He talked with Mr. Lew Turner about his concern in late 1972. As General Meredith recalled,

> Lew said, "I'll tell you what. If you will go back and write a memo for my signature, bring it back up here for my secretary to retype on Air Force Secretarial stationery, I'll issue it to them [Director of Civil Engineering]." I remember that memo; it's in the file somewhere in the archives. That memo said, "You will set the force structure of the combat capability of Civil Engineering of the Air Force, in terms of Prime BEEF and RED HORSE forces, at a level not to go below 37,000 Prime BEEF troops, unless base closures or such as that direct such reductions. On those bases that remain in the structure, the Prime BEEF force structure will remain consistent with that in current programs. In addition, the RED HORSE forces will remain, with at least one in the Pacific, one in Europe, and not less than two in the United States, with further emphasis placed on the Air National Guard and Air

> Reserve." This recognized that maintaining the Prime BEEF structure at the bases meant that at any time you could expand RED HORSE to meet needs and augment the bases with contractors. He signed that memo.[687]

During the early 1970s, RED HORSE squadrons were reorganized. When squadrons were transferred back to CONUS, they were transferred without equipment or personnel. RED HORSE squadrons were reconstituted along slightly different lines. The post-Vietnam units had a different focus, emphasizing base development planning and contingency response. The units, manned with lower skilled personnel than their predecessors, adopted a new organizational concept to make them more responsive. Under the new structure, RED HORSE squadrons were deployed in phases. The first phase was the advanced echelon comprising 14 persons (CES-1) capable of deploying within 12 hours to survey the location and to plan work. The second deployment comprised 81 persons (CES-2), 46 pieces of equipment, and personnel support structures, such as tents, generators, and spare parts; all equipment was air transportable. CES-2 deployed within 72 hours. The new structure was designed to increase mobility and flexibility into deployment operations.[688]

Projects that afforded RED HORSE squadrons and Prime BEEF teams with the opportunities to develop their skills in recovery situations in challenging environments were actively sought. These types of projects not only provided training for deployment and advanced skills, but also completed projects benefitting Air Force installations. Such projects in the early 1970s included the construction of a bombing and gunnery range at Blair Lakes, Alaska, by the 819th RED HORSE, and the construction of four pre-cast concrete aircraft shelters to test live fire weapons at Eglin Field No. 7, Florida, by the 557th RED HORSE. A third project was the construction of new prototype hardened aircraft shelters at Nellis AFB, Nevada, by the 820th RED HORSE.[689]

Humanitarian

Civic Action Programs

During the 1960s, the Air Force was engaged in an increasingly active civic action program. Civic action by military personnel was advanced in a 1961 speech by President John F. Kennedy in which he endorsed the "use of military forces in less developed countries in the construction of public works and other activities helpful to economic development."[690] This proposal became the foundation for an active outreach program under which military forces were deployed to complete projects benefiting local populations. Projects contributing to economic and social development were undertaken in the areas of education, training, public works, agriculture, transportation, communications, health, and sanitation.[691]

The majority of the Air Force's civic action programs during the early 1960s were completed by Air Force civil engineers stationed at overseas bases. The Air Force did not contain dedicated engineer construction teams during the early 1960s. As a result, teams of engineers for civic action programs were assembled on an as-needed basis. Most projects involved the development of air transportation and construction support for airstrips and airfields. For example, Air Force civil engineers supported the Bolivian military in developing a unit, known as the Transporte Aéreo Militar, which provided regular air transportation to 28 airfields and 52 landing strips located in remote areas that were not served by commercial airlines. In Panama, Air Force personnel airlifted airstrip construction supplies into isolated villages that were interested in developing airstrips, and broadcast construction instructions by loudspeakers to complete the airfields.[692]

Air Force engineers trained unskilled laborers in Libya, Iran, Colombia, and Venezuela to repair motors and to use power tools. Local residents in Ethiopia, Greece, Guatemala, and Morocco were taught how to provide water systems for their communities. In Mexico, engineers provided training in aerial geologic surveying and forest firefighting. Technical training classes for Latin Americans were taught in Panama and at Wright-Patterson AFB, Ohio.[693]

During the 1960s, most civic action efforts were informal and based on the needs of local communities. After the establishment of Prime BEEF and RED HORSE during the mid-1960s, Air Force civil engineers assigned to these units became a valuable resource to staff Air Force civic action projects. Some projects undertaken during the early 1960s included the construction of a new school playground and sports field at Steinbach by the 38th Civil Engineer Squadron at Sembach AB, West Germany; firefighting assistance to the local community by the Aviano AB firefighters in Italy; and, combating a water shortage for a local community near Naha AB, Japan. In South Vietnam, Air Force civil engineers supported an orphanage near Tan Son Nhut AB near Saigon. The civil engineers constructed a cess pit with a sanitary community toilet; dug a well and installed a hand pump; built a shower facility; and, constructed a community kitchen and a dispensary.[694] Most RED HORSE squadrons in Vietnam provided assistance to local orphanages and nearby villages.[695] For example, the 556th drilled a well for a neighboring leper colony to provide clean water to avoid illness from typhoid, constructed a dining hall for a local school, and constructed a floor in an orphanage.[696] Such projects sought to foster good will among local communities.

In 1970, Air Force civil engineers began a formal civic action program. The High Commissioner of Micronesia, a 3 million square-mile territory created by the United Nations in 1947 and administered by the United States, requested assistance to develop the territory's communication and transportation infrastructure and to complete other development projects. Micronesia comprised 2,100 islands populated by speakers of nine different languages. The area had sustained major damage during fighting in World War II.[697]

Preparation for Air Force civil engineer involvement in the project occurred during summer 1969. A 21-man team of engineers and site development specialists from the CEC, augmented by PACAF personnel, visited the Trust Territory of the Pacific Islands to assess civic action activities that would benefit the region. The group also surveyed U.S. Air Force real estate left unused since World War II. In 1969, the Office of the Secretary of Defense and the Department of the Interior also decided to send six 13-man civic action teams to various Trust Territory islands. The Navy furnished the first six teams. When it came time to replace personnel serving on the teams, the Office of the Secretary of Defense decided to replace one Navy team in the Marianas with a team of Air Force personnel. CEC undertook the implementation of the Air Force involvement by selecting and training the teams.[698]

On May 6, 1970, a 13-person Prime BEEF team 70-8 arrived on Pagan Island in the Marianas District of Micronesia. The AFCEC assembled the team from volunteers representing 12 different Air Force bases and 7 major commands. The team comprised 11 civil engineers and included an officer-in-charge, a non-commissioned officer-in-charge, two heavy equipment operators, one grounds maintenance specialist, two carpenters, one plumber, one welder, one power production technician, and one site developer. A medic and a vehicle repairman also were assigned to the team. The team assembled on April 5, 1970 and completed three days of training at the CEC; one week of orientation and training at the Naval Construction School, Port Hueneme, California; and, two weeks of orientation by the Commander-in-Chief, Pacific. When deployed, the team was operationally responsible to and received logistical support from the U.S. Navy. As reported by Capt. Max W. Day, "the team… was unique in several respects: It was largely an all-volunteer team; it was not to be involved in contingency, emergency, or recovery operations; and it was the first Air Force Civil Engineering Team to be deployed specifically for civic action purposes."[699]

Prime BEEF team 70-8 spent eight months on Pagan Island, an area with a resident population of 43. The objectives of the team were to befriend the local population, to provide on-the-job training to local residents in the crafts represented by the team members, and to complete projects selected by the islanders and their local government. The Prime BEEF team was transported to Pagan Island by a Naval LST, along with building materials, 20 pieces of heavy equipment, a generator, and food and supplies for 60 days. Additional food was air-dropped every two weeks.[700]

On Pagan Island, the team built its wood-frame quarters, three maintenance shops, and a water catchment system. All buildings were turned over to the residents when the team left. It also constructed a concrete-block dispensary and recreational facilities, including a softball field and a children's playground; upgraded eleven miles of roads; and, rehabilitated an airfield. The team's largest project was rebuilding an overgrown, Japanese-built airstrip that had been bombed during World War II. The airstrip still had craters. By early October, the team had completed a silty clay and lava ash airstrip that measured 2,600-feet long by 60-feet wide and flanked by 20-foot shoulders. The first aircraft landed on the airstrip on October 6, 1970. The team also built a school and a dispensary on nearby Agrihan Island. Prime BEEF team 70-8 was particularly successful at establishing personal connections with the island's 43 residents. The team's medic delivered two babies. During their stay, the team members provided a school for the children, organized softball games, and taught the residents first aid and other skills. When the team departed, residents hosted a dinner and the children sang a farewell song. "This is military civic action at its best," Captain Day stated in describing the team's work.[701]

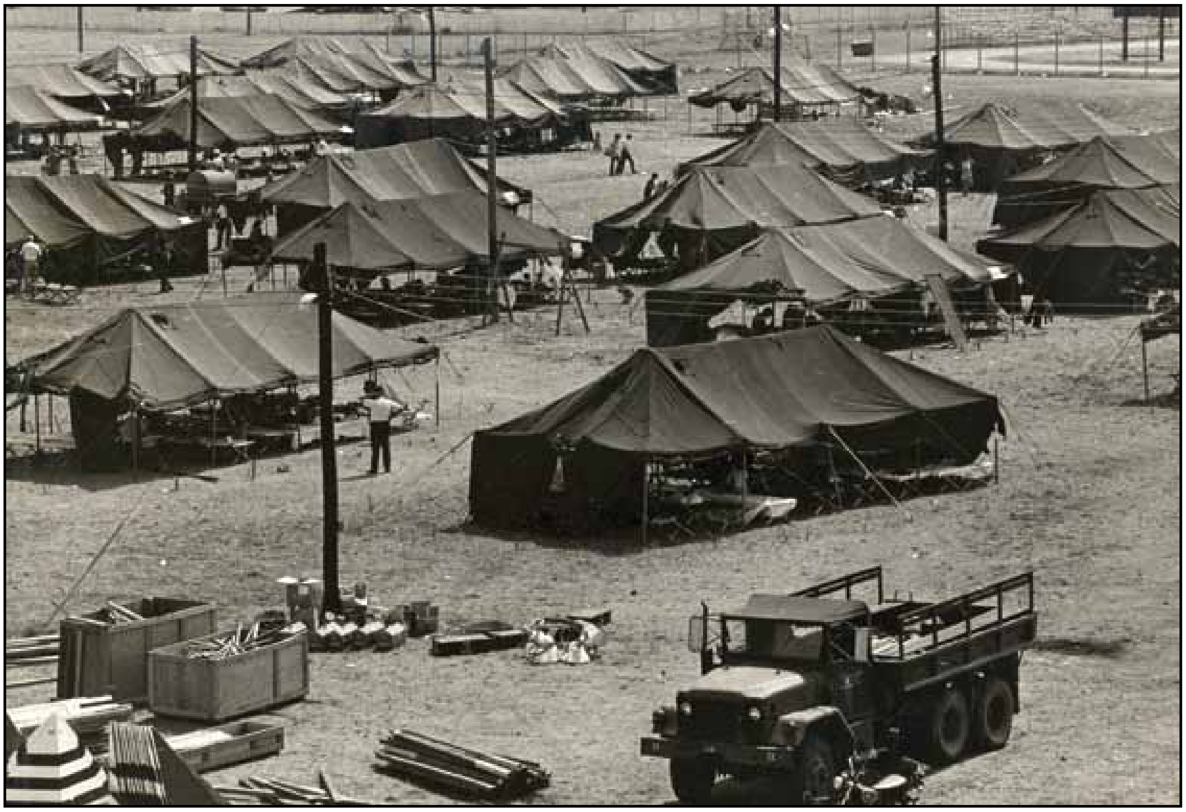
Thus began a yearly deployment, organized by CEC, of Air Force Civil Engineers who participated in civic action in the islands of the Pacific Ocean. In 1971-1972, Prime BEEF teams 71-1, 72-1, and 72-4 were deployed to Tinian Island, also located in the Marianas District. These teams built an irrigation system, cleared 40 miles of roads, built recreational facilities, and completed other projects. They also provided training in first aid and building trades to the local residents.[702] In 1973, Prime BEEF teams 73-4 and 73-10 were assigned to Pagan, Rota, and Tinian Islands in the Marianas.[703]

Vietnamese Refugees

Air Force civil engineers extended assistance to refugees who left the Republic of South Vietnam when that country fell to the Viet Cong in April 1975. Then-Brig. Gen. William D. Gilbert, Deputy Chief of Staff for Civil Engineering at Pacific Air Forces, witnessed thousands of refugees arriving by military and civilian aircraft into U Tapao Royal Thai AFB, Thailand, on the night Saigon fell in April 1975. General Gilbert was appointed refugee control officer and arranged to relocate and house 6,000 to 7,000 refugees in tent cities at Clark AB, Philippines; Andersen AFB, Guam; and, in mothballed family housing, club facilities, schools and former Federal Aviation Administration housing on Wake Island. Water supply at Wake Island was a major concern as civil engineers from Hickam and contractors restarted the standby water distillation plan to produce the water required. The refugees stayed in these temporary quarters before being transported to processing centers for settlement in the United States.[704]

Eglin AFB, Florida, was one site selected as a refugee resettlement processing center. In five days between April 27 and May 4, 1975, a tent city to house 5,000 Southeast Asia refugees was constructed in an area of sand and pine trees at a former auxiliary airfield at Eglin AFB. The tent city was completed through the combined efforts of civil engineers from Headquarters TAC, Air Force Systems Command, and Eglin AFB, as well as temporary duty Prime BEEF and RED HORSE personnel. The 3202th Civil Engineering Squadron (CES) from Eglin AFB prefabricated modular wall and floor panels and trusses; the 823d CES (HR), Hurlburt Field, erected hardback tents; and, the 834th CES from Hurlburt Field constructed latrines, laundries, and showers. Eglin AFB civil engineers also procured all building supplies required in the construction. Utility crews from Eglin AFB ensured that the existing water supply and sewer facilities were in working order and supplied electricity to the camp. The shops constructed a model tent to test prefabrication and assembly methods.[705]

The camp was laid out in increments comprising 70 tents with latrines, showers, and laundries. Each tent was designed to accommodate 12 persons. Tent construction relied on prefabricated techniques and assembly line construction methods. In all, 15,000 sheets of plywood; 5,000 pounds of nails; 10,000 feet of plastic pipe; 25,000 concrete blocks; and, three-quarter million board feet of



Tent city constructed at Andersen AFB for Vietnamese refugees, 1975.

2x4s were used to construct the camp. RED HORSE personnel constructed a new three-stage sewage treatment plant, improved roads, hauled supplies, and reactivated a former airfield complete with a Harvest Bare airfield lighting system. Transforming the abandoned airfield into a working field was accomplished in 36 hours.[706]

The first refugees arrived in the camp on May 4, 1975 with only half of the camp completed. Air Force civil engineers completed construction of the entire camp on May 23, 1975. Once construction was completed, operation of the camp was transferred to local base civil engineer operations and maintenance personnel who provided the services normally supplied by a civil engineering squadron.[707]

Emergency and Disaster Response

Air Force engineers played a role in disaster recovery operations in many areas of the United States and around the world. Air Force engineers assisted in the recovery following the earthquake that struck southern Alaska on March 27, 1964. The earthquake, centered north of Prince William Sound, lasted five minutes and registered between 8.5 and 8.9 on the Richter scale. Alaskan Air Command engineers worked with the U.S. Army Corps of Engineers to repair essential utilities at Fort Richardson and Elmendorf AFB.[708] Air Force civil engineers were airlifted to Elmendorf AFB and worked to restore 75 percent of electric power to the base within a 24-hour period. Central heating was maintained to avoid freezing at the sub-arctic base. Radio contact among engineering crews and a fire/reserve radio network proved valuable in the recovery effort.[709] Air Force civil engineers also participated in civilian recovery efforts.[710] The Air Force supplied 60 trailers to house Navy personnel on Kodiak Island.[711]

Air Force civil engineers have responded in the wake of such natural disasters as hurricanes, flooding, and tornadoes. These real life experiences supported the role of Prime BEEF teams in emergency and disaster response.

In September 1965, Hurricane Betsy came ashore in south Florida and slammed Homestead AFB, Florida, with 130 miles per hour winds over an eight-hour period. Electric power was disrupted and many building roofs were destroyed. The Eighth Air Force responded for this event by assembling and deploying 91 active duty engineers as a Prime BEEF team. The team included carpenters, electrical, liquid fuel, sheet metal, and airfield lighting technicians to support Homestead's base operations. These personnel were assembled from nine bases in the Eighth Air Force. With the assistance of contractors and active duty personnel, electrical poles, transmission lines and transformers were replaced; electricity was restored on September 1, 1965. Damaged buildings were secured to prevent further damage. Capt. (later Maj. Gen.) Joseph A. Ahearn praised the team effort, "The Air Force Prime BEEF standards for skill level, number of technicians, equipment authorizations, and mobility, proved highly satisfactory for natural disaster recovery requirements."[712]

In August 1967, a 152-person Prime BEEF team traveled to Alaska to assist the Army in recovery efforts from major floods that devastated Fairbanks and Fort Wainwright. Fort Wainwright was the home of 200 Air Force families stationed in Alaska. The Prime BEEF team was composed of personnel with specially selected skill sets. Team members were selected from 23 installations in six major commands. When the Prime BEEF team arrived, the housing and operational areas at Fort Wainwright had been without electricity, heat, water, and sewage services for 12 days. One of the first tasks for the Prime BEEF team was to repair and reactivate the runway lighting system. Electricity was restored to 1,420 housing units by the third day of deployment. Ten firefighting personnel on the Prime BEEF team pumped water from building basements. Four electricians on the team repaired 76 electric motors in the south power plant and an additional 94 critically needed motors. Utilities were inspected and reinsulated as needed. A 54-person Prime BEEF team from Elmendorf AFB, Alaska, was deployed to assist Eielson AFB in recovery efforts. In all, 206 Prime BEEF team members deployed between August 22 and September 8, 1967. NCOs on the Prime BEEF team ensured the scheduling of tasks and completion of work throughout the deployment and assured the success of the mission.[713]

Two other Prime BEEF deployments occurred during 1967. Sixty troops assisted with clean-up efforts at Tyndall AFB in Florida following a tornado. Another group of 30 Prime BEEF personnel traveled to Antarctica to work with other Air Force and Navy units to rehabilitate and build facilities.[714]

In August 1969, Hurricane Camille slammed into the Gulf Coast. Airmen from Keesler AFB in Biloxi, Mississippi, joined personnel from the U.S. Army Corps of Engineers and Seabees to conduct recovery operations. A total of 1,700 construction troops used 475 pieces of equipment.[715] A Prime BEEF team was activated to support the recovery efforts at Keesler AFB. These groups repaired bridges on main roads leading to the base, repaired the overhead electrical distribution system and runway lighting, operated and maintained emergency generators, disposed of debris, and repaired roofs and windows on damaged buildings. The 199 members of Phase I, Prime BEEF Team 70-4 included specialists in structural engineering, power, and paving, as well as sheet metal workers. The equipment moved in to complement the team included cranes, line trucks, bulldozers, and generators.[716]

On June 19, 1972, Hurricane Agnes swept across the Florida panhandle and continued north through the Mid-Atlantic region as a tropical storm. The storm resulted in heavy rainfall and caused dramatic flooding. After crossing into the Atlantic Ocean, Hurricane Agnes regained strength and swung back inland across New York State and looped into Pennsylvania on June 24, 1972. The result of the storm was severe flooding from Virginia northward to New York. The Susquehanna River basin from New York southward through Pennsylvania and Maryland was particularly hard hit. Wilkes-Barre, Pennsylvania, suffered particular devastation.

President Nixon declared the area a Federal disaster area and appointed a coordinator to organize Federal relief efforts. The government requested engineering assistance from the Army, Air Force, and Navy. The Air Force responded by sending a joint Prime BEEF/RED HORSE Team 73-2 in August 1972. Named the Ready Repair Team, this team comprised 20 persons from the 819th CES (HR) stationed at Westover AFB, Massachusetts. The team was deployed with four jeeps, two ¾ ton cargo

Civil engineers from Ellsworth AFB use a crane to remove cars during flood relief operations in Rapid City, South Dakota.

trucks, and two pickup trucks. The initial team was augmented by seven, three-man crews deployed from MAC, TAC, AFLC, AFSC, and HQ Command for a total of 41 personnel. Their assignment was to complete minor repair jobs for families occupying HUD-provided mobile homes. HUD (U.S. Department of Housing and Urban Development) had secured 8,000 mobile homes and installed them in 33 trailer parks and next to damaged houses. These mobile homes were transported from a 17-state area and often arrived requiring minor repairs. The Air Force's Ready Repair Team worked in Kingston and Wilkes-Barre, Pennsylvania, to ready the mobile homes for occupation by storm victims. Typical repairs included leveling the mobile home, checking heating units and other utilities, and repairing interior finishes. When the Air Force engineers ended their deployment in October 1972, the engineers had repaired 1,533 trailers at individual sites and 1,904 trailers in trailer parks.[717]

Air Force civil engineers also participated in the Mini-Repair Program under the direction of the Office of Emergency Preparedness. The Mini-Repair Program completed basic repairs up to $3,000 to make dwellings habitable. Repairs were restricted to safety and utility services, such as fixing leaky roofs, supporting foundations, repairing doors and windows, and ensuring safe and working utility connections. The Air Force also monitored civilian contractors involved in the program. In September 1972, forty Air Force civil engineers with specialties in carpentry, electrical work, and plumbing and heating arrived in Wilkes-Barre, Pennsylvania. These personnel were drawn from the 820th CES (RH) from Nellis AFB, augmented by personnel from Prime BEEF teams assigned to ADC, ATC, and AFSC. By the time the team left the field in November 1972, members had completed 957 final inspections amounting to 35 percent of the total program effort.[718]

On the night of June 9, 1972, a severe thunder storm struck a 75-mile area around Rapid City, South Dakota. The torrential rainfall resulted in severe flooding. A 10-foot wall of water raced down Rapid Creek, crashed through an earthen dam, and washed away homes in Rapid City. By the next morning, 225 persons in Rapid City were dead and many homes were washed away.

Military personnel assigned to nearby Ellsworth AFB assisted in the clean-up efforts for the damaged town. The Base Civil Engineer served as the military liaison with the Civil Defense Control Center. The 821st CES under the direction of the Chief of Operations and Maintenance directed base military personnel in recovery operations. Following the Prime BEEF model, some civil engineers were assigned to teams to perform specialized tasks. These teams included heavy equipment operators and utility specialists tasked with restoring electricity and other services. The majority of the base volunteers assisted in more general tasks. The base made its hospital, gymnasium, dining hall, and community center available to the community. Assistance also was rendered in debris removal, and search and rescue operations. Ellsworth AFB shared potable water from its deep wells with the community.[719]

On April 3, 1974, a series of 148 tornados struck 10 states and Canada in a 24-hour period. The weather system killed 328 persons, injured hundreds, left 5,000 homeless and resulted in hundreds of millions of dollars in damage. The storms struck parts of Alabama, Georgia, Illinois, Indiana, Kentucky, Michigan, North Carolina, Ohio, Tennessee, West Virginia, and Ontario, Canada.[720]

In Xenia, Ohio, a tornado wiped out 30 to 40 percent of buildings and homes, including the homes of 293 employees, both civilian and military, of nearby Wright-Patterson AFB. Within two hours, civil engineering personnel from the base, as well as members of the 820th CES (HR) from Nellis AFB, who were deployed at the base, proceeded in convoy to Xenia to render assistance. The convoy included bulldozers, vehicles, and tow vehicles with generators and floodlights. The Air Force civil engineers repaired overhead utility power lines, operated emergency generators, conducted search and rescue operations, cleaned up and disposed of debris, and assisted railroad crews to clear the rail tracks in the center of town. Air Force civil engineers remained on the scene for three-and-a-half days.[721]

Challenges Ahead

The years extending from 1960 to 1974 were a period of challenge, success, and professional accomplishment for Air Force Civil Engineering that was forged against a back drop of military conflicts. The participation of Air Force civil engineers in the Vietnam Conflict recast their role in military construction and honed professional skills invaluable to meeting the demands of future war situations. After 1973, a period of long-time peace presented new challenges for Air Force civil engineers.

Maj. Gen. Maurice R. Reilly, Director of Civil Engineering from 1972 to 1974, viewed the primary challenge facing the organization as managing valuable resources in an environment of fiscal restraint. In 1974, the combined military and civilian Air Force Civil Engineering workforce of 76,000 managed a physical plant with a replacement value of $55 billion. New facilities were acquired to serve new and changing missions, costing a total of $1.5 billion to $2 billion annually. “The challenge,” General Reilly wrote,

> is to achieve an optimum balance between numbers of personnel, supplies, and contract services while, at the same time, achieving maximum control and conservation of expensive utilities and other related public works services. Coupled with this balance and control, there must be improved work force productivity which will result in maximum output for each dollar invested. The key to meeting this challenge is the Base Civil Engineer and his organization.[722]

General Reilly identified three areas requiring focused attention. First, engineers needed to use their experiences from their combat support role in Vietnam to plan for future contingency support to maintain and improve readiness. Engineers also needed to apply their experience to refine contingency programs such as bare base, RED HORSE, and Prime BEEF. Second, engineers needed to “find new methods, techniques, designs, construction innovations, and management improvements to obtain the maximum construction for every invested dollar."[723] Construction costs were projected to rise over the years, but Air Force construction appropriations were not. Meanwhile, Air Force facilities continued to require modernization to meet environmental and energy-saving targets. Civil Engineering was critical to mission support and to enhancing the Air Force standard of living necessary to retain personnel in the all-volunteer Air Force.[724] Third, rising construction costs required innovations in facility acquisition, construction management, and technology, such as the turnkey procurement method or the use of solar energy. General Reilly concluded, "Air Force construction resources must be applied not only to achieve timely, economical, and functional facilities, but also to obtain minimum life cycle costs and maximum energy conservation."[725]

Maj. Gen. Billie J. McGarvey, as he ended his tour as Director of Civil Engineering in April 1975, reflected,

> For the future, our career field holds new challenges which are very similar to those now facing our nation at all levels of government. Concerns for people, equal opportunity for all, and responsiveness to operational needs are generating the demands for professionals with a broader perspective than pure technical sufficiency…I anticipate that Air Force Civil Engineering will approach this challenge with the same "can do" attitude for which we are noted.[726]

CHAPTER 4

BUILDING ON SUCCESS
1975-1990

INTRODUCTION

In April 1975, Maj. Gen. Robert C. Thompson became Air Force Director of Civil Engineering. At the time, the Air Force Civil Engineering organization comprised more than 76,000 military and civilian personnel.[1] This workforce managed 139,951 buildings on 135 major bases and 2,913 other installations occupying over 10.9 million acres valued at more than $17.2 billion.[2] General Thompson reflected on the current challenges and opportunities as he saw them:

> As I look to the future in Air Force Civil Engineering, the emphasis is on programs for people—also, all indicators point toward the continuing need for us to do more with less. We have, in nearly all areas, trimmed the fat from traditional methods of operation, but now, even this is not enough. We are entering an era of change. A time for finding new ways of doing things, innovation, breaking with tradition, and new ideas—and it is a time for the best leadership that we have ever known.[3]

As the U.S. military regrouped following the Vietnam Conflict, post-Vietnam military budgets were slashed across the board. Military spending, which had accounted for 42.1 percent of the total Federal budget in 1968, dropped to 23.7 percent in 1977.[4] The overall Air Force Military Construction Program was funded at approximately $300 million and remained at that level through FY78.[5] U.S. Congressional oversight of Air Force construction spending increased; all expenditures were justified exhaustively.[6] In addition to reduced military funding, the end of the draft and the transition to an all-volunteer force in 1973 resulted in reduced enlistments for all services for several years. The Air Force made strides to improve quality of life to attract and retain qualified personnel.

Civil engineers who entered the Air Force in the mid-1970s faced several challenges. The transition to the all-volunteer force brought changes to the base-level squadrons which comprised wartime-trained civil engineers, civilians, and many non-engineers who were placed in the units until moved during the on-going downsizing and force reductions. Several squadron commanders had little or no experience in civil engineering. The engineers also worked under some outdated regulations and guidance and were just beginning to enter the computer age with the Base Engineer Automated Management System or BEAMS. With the support of leaders such as Maj. Gen. Robert C. Thompson, Maj. Gen. William D. Gilbert, and Maj. Gen. Clifton D. "Duke" Wright, Jr., Air Force Civil Engineering began to remake itself, emphasize professionalism, improve operations at the base level, transform bases into efficient and attractive "cities," and hone in on its readiness mission.

The Air Force refocused its operations and priorities on the overall world-wide mission. Containment of the U.S.S.R, the major military adversary, was central to U.S. international policy during the late 1970s and the 1980s. During this time period, the U.S.S.R. initiated a major expansion of conventional and nuclear military weapons. U.S.S.R. military expansion included a major naval escalation; the development and deployment of new land-based intercontinental ballistic missiles directed at Western Europe and Japan; a "large new supersonic warplane;" and, greater investment in military research and development programs compared to the United States.[7] Maj. Gen. William D. Gilbert, Director of Engineering and Services for the Air Force from 1978 to 1982, warned, "There is a very real danger in permitting the Soviet military advantages to grow to where the Soviets will feel free to use force wherever they please."[8]

The U.S.S.R. buildup was monitored with growing unease by Western Europe and NATO allies, as well as the United States. It was speculated that the U.S.S.R. sought greater influence in Western Europe and possibly planned to restrict western interests. The United States increased U.S. troop strength, improved our European bases, and increased support for NATO operations.[9]

In addition to concern over U.S.S.R. military expansion, the United States maintained long-standing commitments to the Republic of Korea, Japan, and other countries in the Far East, as well as pursued interests in Central and South America. During the late 1970s, U.S. interest and involvement in the Middle East also grew owing to our reliance on Middle East oil, participation in the 1978 negotiations between Israel and Egypt, and the regional events following the 1979 overthrow of the Shah of Iran.

Throughout the 1980s, the primary global issues were identified as "the Soviet threat, terrorism, alliances, nuclear proliferation, petroleum, space, mineral resources, foreign arms trade, and population."[10] To counter the threat, General Gilbert, supported the Department of Defense (DoD) strategy to develop and to deploy the MX intercontinental ballistic missile system, to make air- and ground-launched cruise missiles operational, and to develop capacity for worldwide mobility. For Air Force civil engineers, these priorities meant supporting air operations during conflicts by developing runways, support facilities, and utility systems "as basic and essential parts of our weapons system acquisition and follow-on operational capability."[11]

The most likely wartime scenario defined by the Joint Chiefs of Staff was a conventional war in Western Europe during which the Air Force would operate from main bases, such as Ramstein AB, Germany, with a system of collocated operating bases supported by bare bases established as needed. The main tasks identified for civil engineers in this scenario were:

- emergency rapid repair of damaged critical facilities, including rapid repair of airfield pavements;
- immediate bed down of deploying fighting forces;
- crash rescue and fire suppression; and
- operation/maintenance of the weapon system platform, i.e., the air base.[12]

Civil engineers worked to improve and to refine the concepts and procedures for air base survivability, rapid runway repair (RRR), base recovery after attack (BRAAT), bomb damage repair, and readiness—readiness both of installations, equipment, and of personnel.[13] The realization of these concepts into procedures shaped manpower allocations, personnel training, and research and development (R&D) efforts. Air Force Directors of Engineering and Services continually defended manpower authorizations to ensure adequate personnel numbers to meet military deployment requirements. Training for Prime BEEF, RED HORSE, and Prime Readiness in Base Services (RIBS) was expanded to provide hands-on experiences in simulated wartime activities and conditions.

During the time period, Air Force Civil Engineering was reorganized several times. In 1975, Air Force Civil Engineering and Services were merged to form the Directorate of Engineering and Services. In 1978, a second reorganization resulted in the formation of the Air Force Engineering and Services Center (AFESC). Air Force civil engineers managed increasingly larger budgets to fund construction projects, and to repair, maintain, and operate facilities on the bases.

Military appropriations slowly rose during the latter years of the Carter administration in the late 1970s. The proposed budget for the FY79 Military Construction Program included a request from the Air Force for $1.4 billion; $720 million was funded.[14] After Ronald Reagan was inaugurated as President in 1981, military budgets grew exponentially. The Air Force Military Construction Program increased to $1 billion.[15] Funding also increased in non-appropriated funding, Unspecified Minor Military Construction (P-341) P-341 funds, funds, and operations and maintenance funds that included repairs up to 300,000 dollars.[16] Air Force civil engineers expended these funds to build facilities to support new weapons and to modernize older facilities to increase energy efficiency and to reduce maintenance and repair expenditures. Operations and maintenance funds were allocated to address the backlog of deferred facilities maintenance under a program known as BEMAR for "backlog of essential maintenance and repair." By the mid-1980s, the Air Force budget reached levels of $100 billion.[17] While military budgets expanded, the overall personnel numbers in the Air Force Civil Engineer organization did not increase substantially. After 1985, Air Force construction budgets declined.

During this time period, Air Force civil engineers embarked on a variety of programs to respond to military missions and to new legal requirements. Air Force civil engineers sought to improve the quality of life for Air Force personnel through upgrades to dormitories, dining halls, personnel support facilities, and work places. Efforts were made to enhance the architectural appearance of bases through improving base comprehensive planning and architectural design for construction and renovation projects. Improvements to managing the bases were continually reevaluated and professional management procedures were incorporated. Protection and restoration of the environment was assigned to the Air Force civil engineers for implementation. Terms such as environmental impact statement, installation restoration, and pollution abatement entered into Air Force civil engineers' everyday language. Air Force civil engineers also extended a helping hand when disasters struck. They were there when bases recovered from natural disasters and assisted other Air Force bases, local U.S. communities, and international communities in disaster recovery efforts.

During the late 1980s, geopolitical conditions began to shift dramatically as the relationship between the United States and the U.S.S.R. thawed and the promise of new freedoms were introduced into the Warsaw Pact counties. The world changed on November 9, 1989, when the Berlin Wall dividing East and West Berlin was opened. These events presaged a new world order that required re-imaging, redefinition and realignment of U.S. military forces, including the Air Force. Definite changes foreseen for the 1990s were reorganization of the Directorate of Engineering and Services and major personnel reductions.

CIVIL ENGINEERING AIR STAFF PROGRAMS AND POLICIES

Directors of Engineering and Services

Air Force Civil Engineering history during this time period generally was characterized by three broad and successive themes. Between 1973 and 1978, the civil engineering organization focused on customer service. Attention was placed on management and on establishing internal procedures and policies to perform civil engineering duties more effectively with the end user in mind. Between 1979 and 1984, "quality of life" programs became the focus of the organization through rebuilding facilities to modernize bases and to support the welfare of the entire Air Force family. A second emphasis was personnel readiness. Beginning in 1985, civil engineering priorities shifted to concentrate resources and personnel to wartime readiness.[18] Finally, throughout the time period, the civil engineering organization pursued professionalism in personnel, in management skills, and in customer service. The Engineering and Services Directors also sought to instill quality management policies and procedures by adopting contemporary business organizational and management methods and automation tools to improve systems management in the civil engineering organization at the bases, major commands, and the Pentagon.

Talented and innovative Directors of Engineering and Services serving at Headquarters U.S. Air Force in the Pentagon guided the Air Force Civil Engineering organization throughout this time period. Each director was a major general, who served with a brigadier general as deputy. Each director also was supported by a long-term, experienced civilian from the Senior Executive Service. Between 1975 and 1990, each director served approximately three to four years prior to retirement, so that there was a continual rotation of top leadership. Typically, the director was succeeded by the deputy director, which provided a measure of organizational continuity.

Maj. Gen. Robert C. Thompson

Maj. Gen. Robert C. Thompson succeeded Maj. Gen. Billie McGarvey as Director of Civil Engineering in April 1975 and served until June 1978. Under his leadership, Air Force Civil Engineering and Air Force Services were merged to form the Directorate of Engineering and Services. Services included food service (i.e., dining halls and personnel meals); laundry and dry cleaning; linen exchange; billeting for furnished enlisted dormitories; bachelor officer quarters; transient living facilities; and, mortuary affairs. Services also provided technical assistance and guidance to commands and installations on "food, management, facilities, training equipment, contract surveillance, and subsistence control procedures."[19]

General Thompson's primary interest was to ensure a successful integration of Services with Civil Engineering and to ensure that Services personnel had the support they required to serve the Air Force community.[20] General Thompson supported programs that bettered living and working conditions for Air Force personnel on bases. Maj. Gen. Clifton D. Wright, Jr., Air Force Director of Engineering and Services, 1982-86, remembered Thompson as "a brilliant and dynamic leader, a real visionary with the ability to get into the details of most every program. General Thompson's vision to create a comprehensive organization to plan, provide, maintain, and operate things where Air Force people lived, worked, and played was becoming reality and gaining momentum."[21] He focused on three key areas to improve base civil engineer (BCE) operations. These key areas were involving base commanders in the civil engineering business, improving BCE productivity through production control centers, and an emphasis on building teams among the civil engineers on base.[22] General Thompson was interested in programs that improved dormitories, child care centers, youth centers, base exchanges, and commissaries. Gen. Wilbur L. Creech, Commander, Tactical Air Command, recalled, "And, of course, his thrust was not only the facilities, but also the quality of the services that are carried out within them. He had an…oft-used expression: 'Our people deserve and must get first class service,' and, by word and deed he showed that he clearly meant service with a heart, and with a smile, and with pride of accomplishment."[23] To honor his service, the Maj. Gen. Robert C. Thompson Award was established to recognize the year's most outstanding Resources Flight.[24]

Maj. Gen. William D. Gilbert

Maj. Gen. William D. Gilbert served as Director of Engineering and Services from July 1978 through August 1982 after having served as deputy director since May 1975. Under General Thompson, General Gilbert ran the day-to-day operations of the Directorate of Engineering and Services at Headquarters U.S. Air Force. As director, General Gilbert continued the work with the merger and was noted for promoting the quality of life programs, coining that term to describe those programs. Under General Gilbert's leadership, the organization placed greater emphasis on incorporating efficient management procedures into all levels of the organization and on readiness of both facilities and personnel. General Gilbert oversaw two Air Staff reorganizations and the creation of the Air Force Engineering and Services Center (AFESC), successfully defended civil engineer military manpower requirements, and was skilled in presenting the civil engineer program budgets to the U.S. Congress.

General Gilbert also sought to instill pride in Engineering and Services personnel.[25] He emphasized that civil engineers and services personnel should be professional, effective, efficient, and innovative. They should acquire professional skills in their respective areas of expertise, and also acquire leadership skills necessary to function effectively. Learning to be leaders meant acquiring skills in organizational management.[26] Educational opportunities were made available for military civil engineers to attend courses in business management. Professional organizational and management concepts began to appear in the pages of the *Engineering & Services Quarterly* and to be applied throughout the civil engineering organization. Some of these concepts included communication skills, financial management tools, "Management by Objective," and "Engineered Performance Standards." To honor his service, the Maj. Gen. William D. Gilbert Award was established to recognize the efforts of staff action officers. Awards are presented to an officer, an enlisted member, and a civilian.[27]

Maj. Gen. Clifton D. "Duke" Wright, Jr. served as Director of Civil Engineering and Services between August 1982 and February 1986. General Wright continued the quality of life programs. The challenges facing Civil Engineering and Services during the mid-1980s as summed up by General Wright were managing personnel resources, adopting automation to control and manage data, improving base-level productivity through the Project IMAGE program, involving Engineering and Services

Maj. Gen. Clifton D. "Duke" Wright, Jr.

personnel in the weapons development process to ensure that field facilities supported the weapons system, improving readiness and sustainability, modernizing air base facilities to improve combat capabilities and to enhance quality of life, and conserving energy.[28] General Wright had particular interests in architectural design excellence, cost control and construction procedures and processes. General Wright also established the historian position at the Air Force Engineering and Services Center in 1985 to document the history of the Engineering and Services career fields.

From August 1982 through May 1983, General Wright led senior leadership to develop the Engineering and Services Strategic Plan. The plan was reviewed and validated during the initial meeting of the Engineering and Services Requirements Board in March 1983 hosted at AFESC at Tyndall AFB, Florida.[29] Published in May 1983, the strategic plan contained ten major goals in four categories. Each goal had one or more objectives and each objective had strategies for short-range (one to two years), mid-range (three to five years), and long-range (five or more years) timelines. In all, 185 strategies were identified under the objectives.[30] The strategic plan was revised twice during General Wright's tenure.[31] General Wright's other accomplishments included:

- Maturing Services business and helping build and sustain the career field and related facility upgrade and customer service that directly affected the quality of life for Air Force people;
- Institutionalizing MILCON, O&M, and Non-Appropriated Fund project and program planning, design and construction project delivery processes, and forming senior-level program review groups to manage major programs;
- Creating a team of outstanding people in the Pentagon and at major commands that bonded and worked together;
- Institutionalizing comprehensive planning procedures and fostering a culture that understands and promotes quality architectural design;
- Restructuring of Prime BEEF and creating Prime RIBS teams; and,

Maj. Gen. George E. "Jud" Ellis

- Developing initial training sites and programs to train civil engineers and Services people to support the operational Air Force."[32]

To honor his service, the Maj. Gen. Clifton D. Wright, Jr. Award was established to recognize the year's most outstanding Operations Flight.[33]

Maj. Gen. George E. "Jud" Ellis became Director of Engineering and Services in March 1986. He identified the following important areas on which to focus his leadership: personnel readiness in a joint environment; decentralization and the distribution of responsibility, authority, and accountability; modernizing and expanding automation throughout the Engineering and Services organization; career

Ten Major Goals from the 1983 Strategic Plan

Resource Management

Goal 1: People
Goal 2: Assist Base Civil Engineer/Chief of Resources
Goal 3: Research, development and acquisition

Readiness and Sustainability

Goal 4: Contingency planning, procedures, equipment and facilities
Goal 5: Force posturing and training

Modernization and Lifestyle

Goal 6: Modernization of facilities
Goal 7: Living quarters and food services
Goal 8: Fire protection
Goal 9: Environment

Energy

Goal 10: Energy security and efficiency

development; and, listening to the customers. General Ellis expressed the urgency of personnel readiness most eloquently, when he said, "What is the most important [area] in Engineering and Services? We must prepare to go to war. That's why we are in the business; it's our number one priority!"[34] General Ellis strove to strengthen the mission orientation of military personnel, linking their wartime roles directly to their flying squadron. For General Ellis, it was the responsibility of every individual to understand the relationship between command, leadership, training, and execution.[35]

General Ellis'
Nine Commandments for Engineering and Services personnel:

In 1986, General Ellis addressed a class at AFIT where he laid out his philosophy and priorities as the Director of Engineering and Services. He also included his Nine Commandments.*

1. Thou shall be active.
2. Thou shall stay in touch.
3. Thou shall generate mistakes.
4. Thou shall have value systems.
5. Thou shall know how to communicate.
6. Thou shall know your job.
7. Thou shall know your boss's job.
8. Thou shall make your boss's job easier.
9. Thou shall have fun.[36]

**Why only Nine Commandments? General Ellis said he did not want to upstage Moses.*

Maj. Gen. Joseph A. "Bud" Ahearn became the Director of Engineering and Services in March 1989 and oversaw the organization until January 1992. Because of his extensive experience in Europe and the Middle East, General Ahearn was able to look past the end of the Cold War and envision other less centralized and less conventional threats, including terrorism and the possible proliferation of weapons of mass destruction. As deputy director and then director, General Ahearn worked to develop civil engineering doctrine to highlight organizational flexibility, preparedness, joint operations, and rapid response. General Ahearn also promoted the Air Force's environmental program and shepherded the organization through dramatic downsizing and restructuring that occurred after the fall of the Berlin Wall in November 1989.[37]

Civil Engineer Structural Reorganizations

Three major reorganizations occurred at the Air Staff level between 1975 and 1989. During the 1970s, the civil engineer organization was reorganized twice. The first occurred in 1975 when Civil Engineer and Services officially were merged at Headquarters, U.S. Air Force. The merger between Civil Engineering and Services actually occurred earlier in two major commands, USAFE and PACAF. Total integration of the two functional areas occurred shortly thereafter.

The second occurred in 1978 when the Air Staff was reorganized. The civil engineer organization was transferred to a new directorate within the Pentagon and instructed to reduce personnel assigned to Headquarters U.S. Air Force. The result was the formation of a separate operating agency named the Air Force Engineering and Services Center (AFESC).

During the late 1980s, another round of reorganization of the Air Staff began. This was in response to the end of the Cold War, when a new mission for the U.S. military, and the Air Force in particular, began to be redefined.

Maj. Gen. Joseph A. "Bud" Ahearn

General Ahearn's Letter of February 22, 1989

Dear General McDonald,

Today I accepted responsibility for your Engineering and Services Directorate. As an integral part of the Air Force team, I am accountable for the quality of our base development and operations, the environment, troop feeding and housing, mortuary affairs, and most importantly, ensuring the warfighting readiness of our warriors.

Our goal is to build upon the successes of our proud Engineering and Services team. We will apply five fundamental principles to all our policies and programs. We will (1) focus foremost on improving the quality of the service end product, (2) define and ensure accountability, (3) foster teammanship, (4) apply progressive, proven technology, and (5) be future looking. Our measures of merit will be the fulfillment of commanders' expectations and their mission effectiveness.

The pulse point of mission effectiveness will be the line of the Air Force. Hence, we will give special emphasis to the airmen and the young officers. Our objective is to positively influence retention and set them up for success.

I assure you the Engineering and Services staff will be responsive to your priorities. We will underwrite every program with innovative leadership, a skilled and motivated work force, and our enduring commitment to excellence.

Warm Regards,
Joseph A. Ahearn
Major General, USAF
Director of Engineering and Services[38]

Merger of Civil Engineering and Services

On October 11, 1974, the Air Force Vice Chief of Staff formally approved the transfer of Services from the Deputy Chief of Staff/Logistics to the Directorate of Engineering, forming the Directorate of Engineering and Services. The merger occurred at the major commands by March 1, 1975, followed by the Air Staff at the Pentagon on August 15, 1975.[39]

In the civil engineer organization on the major command level, the three directorate structure approved in summer 1974 was augmented by a fourth new directorate. A Directorate of Housing and Services was added to the existing directorates of Programs, Engineering and Construction, and Operations and Maintenance.[40] The new directorate contained two divisions. The Housing Management Division established a single manager to manage government-owned or controlled housing, bachelor quarters, temporary living facilities, guest houses, off-base housing, and Fair Housing Enforcement programs. The Services Division was responsible for policies for commissaries, clothing sales stores, food service activities, mortuary affairs, laundry and dry cleaning, and linen exchange.[41] Laision with the Army & Air Force Exchange Service also fell under the Services Division.

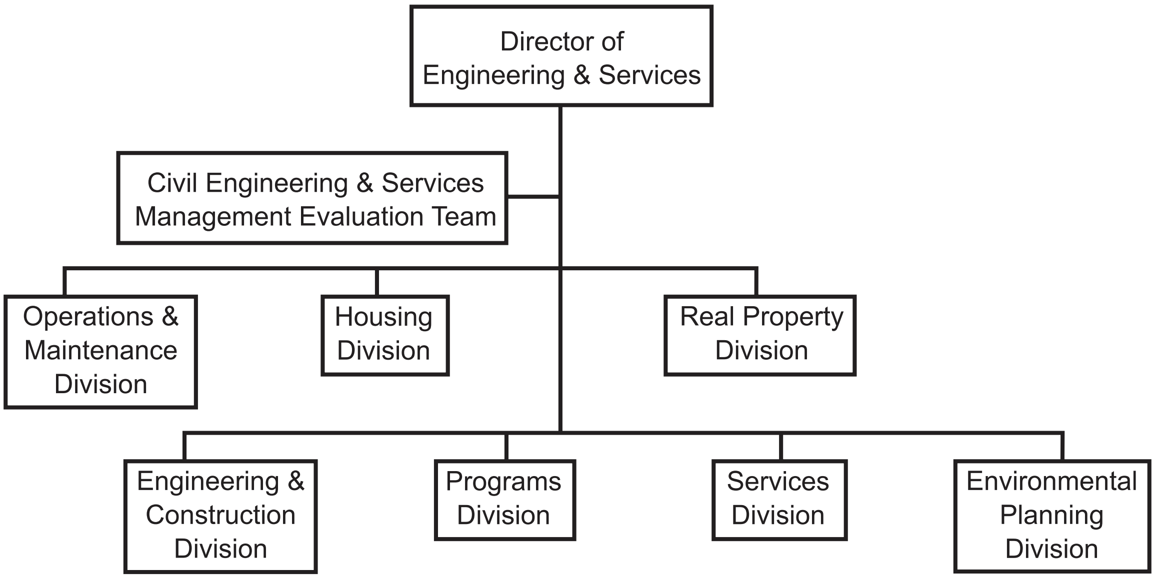
At Headquarters U.S. Air Force, the Services Directorate was combined with the Civil Engineering Directorate to form the Directorate of Engineering and Services under the Deputy Chief of Staff/Programs and Resources. The new directorate comprised the following divisions: Engineering and Construction, Operations and Maintenance, Programs, Housing, Real Property, Environmental Planning, Services, and the Civil Engineering and Services Management Evaluation Team (CESMET) (Figure 4.1). The merger offered advantages to both organizations. For Services personnel, the merger consolidated activities assigned throughout the Air Force organizational structure and provided structure for Services personnel.[42]

Maj. Gen. Robert C. Thompson was well-suited to guide the merger. In previous assignments, General Thompson had worked to improve living and working conditions for Air Force personnel.[43] In 1972, with strong support of Gen. David Jones, Commander in Chief of U.S. Air Forces in Europe (USAFE), he developed plans for and personally managed the merger of Civil Engineering with Services. USAFE was the first major command to effect the merger. While at USAFE, he also initiated programs for the construction of new or upgraded dormitories and dining halls, recreation centers and gyms, consolidated shopping and community centers, and schools, as well as aesthetic and functional improvements to administrative and shop areas.[44]

Pacific Air Forces (PACAF) was the second major command to merge Services with Civil Engineering. This merger occurred under General Gilbert, who was then serving as Deputy Chief of Staff for Civil Engineering in Hawaii.[45] General Gilbert undertook a program to make the PACAF bases modern and attractive places to work, live, and play, and had embarked on a $46 million, multi-year program to upgrade dormitories and dining halls.[46] General Gilbert recalled the merger of Engineering and Services at PACAF. When Gen. Louis Wilson, Jr., arrived at PACAF to become the commander,

> He thought the idea [merger] was great, and one of the first things he did was say to me, "Bill, let's consolidate Engineering and Services."…[The state of the Services was] kind of like stepchildren….Logistics had its plate full maintaining airplanes and weapon systems, and Services was sort of a tagalong. As a matter of fact, Services officers were getting no promotions at all. Even the head of Services at most locations was an ex-materiel person who had just been put into the job. I had no problem integrating them onto my staff. They were happy to come into Engineering in PACAF…[because Services] felt that we were responsible for providing and maintaining so many of the things that they operated on a base—dining halls, dormitories, etc.—and that if they were part of the family, maybe they'd get better support…. I had to do a little ground work with the engineers to appease some of

Figure 4.1 Directorate of Engineering and Services, 1976



Source: HQ USAF Directorate of Engineering and Services Organizational Chart, Files of AFCEC History Office, 1976.

> their fears and concerns, everything from a fear they would take away promotions to questions like, 'What are we doing with Services? It has no similarities to Engineering.' But it worked out and was accepted.[47]

By the 1970s, responsibilities of Services in the Air Force had many things in common with the civilian hospitality, food, and mortuary industries. The quality of services, such as food and dormitories, became particularly important after the advent of the all-volunteer Air Force in 1973. American affluence, social mobility, and rising standards of living created higher expectations by many recruits for living conditions at Air Force bases.[48]

In addition to the functions that supported everyday life in the Air Force, Services also had a vital wartime mission summed up in the word "survivability." According to Capt. David B. White, who was assigned to the Air Force Engineering and Services Center in the Housing and Services directorate, the word survivability had many connotations. It meant "not only the survivability of the facilities, foodstuffs, equipment, etc., but the minimum level of Services support to meet continuing survivability requirements for our personnel in the areas of food service and billeting," in addition to mortuary services, as required.[49] "In wartime, concern over 'quality of life' food service will give way to concern over providing basic meal support, including the use of operational rations and field kitchen produced meals…In wartime, [billeting] priorities will be reduced to concern over a safe, warm, dry, clean place to sleep or live."[50]

While realigning Services functions reduced costs and improved operations, one unfortunate result was that career paths were truncated. Manpower authorizations were misaligned across grades and year groups. Services lost experienced personnel.[51] Despite these problems, the merger with Civil Engineering highlighted the need for a strong Services function and elevated the status of Services in the Air Force. After the merger, Services and Civil Engineering personnel at base level and higher headquarters developed working relationships to further shared goals. Advantages of combining Services with Civil Engineering, from the Services perspective, were gains in organizational structure, manpower standards, personnel management, training and education, and a defined readiness function.[52] The advantage of the merger from the Civil Engineering perspective was access to the applied experiences of Services in designing dining halls and dormitories for functional efficiency. Input from

Services personnel helped keep civil engineers focused on the people that their programs, particularly quality of life programs, affected.[53] The Air Force was the overall winner.

Services personnel classifications were re-allocated and combined to broaden the personnel base and to establish career ladders. Manpower standards for all functional areas within Services were established and job descriptions for both enlisted and civilian personnel were defined.[54] Career advancement for officers in Services presented an early challenge. General Gilbert recalled,

> When Services came over to us and I became Director, I was determined to get them some promotions, because they just simply had not had any. I got myself on their colonels promotion board, and we got three or four colonels. They hadn't had colonels promoted in years and years. The next year we repeated, and we wound up getting some colonels in Services and some lieutenant colonels and majors. They had really been pushed to the side before that…We set out to teach them how to write OERs (Officer Evaluation Report) and how to evaluate themselves, how to evaluate people in their career field…I don't believe they had had a person promoted to colonel in ten years, until I got some people promoted.[55]

In addition to working cooperatively and in better facilities, Services personnel were encouraged to view their operations as systems and apply formal management principles to daily operations. Daily operating standards were revised for billeting and food service operations at Air Force bases by staff at AFESC. Regular management reviews were conducted in food service and billeting operations through CESMET.[56] Installation managers seeking improvement could request assistance from the Food Management Assistance Team fielded through AFESC.[57] Major commands, such as TAC, also fielded Services inspection teams to evaluate and to advise on improving operations, systems, and procedures.[58]

One essential and unique activity under Services was mortuary services. The Air Force Mortuary Services Office managed "the recovery, identification, preservation, transportation, and disposal of the remains of deceased Air Force active duty members and certain other eligible civilian personnel." This office also supervised "the disposition of personal effects of MIA [missing-in-action] and deceased active duty personnel, and…the Air Force military burial honors programs."[59]

The office performed with efficiency and dignity. One high profile situation occurred in Beirut, Lebanon, when, on October 23, 1983, a truck bomb killed 239 Marines. The Marines were stationed in Lebanon as part of a multi-national peacekeeping force requested by Lebanon. The aftermath of this explosion required an extensive mass casualty identification effort. Brig. Gen. Joseph A. Ahearn, then-Deputy Chief of Staff, Engineering and Services, Headquarters U.S. Air Forces in Europe, headed the operation. Rhein-Main Air Base in Germany was selected as the site for identification, while the Army mortuary site at Frankfurt was chosen to embalm the casualties. More than 1,500 people from all military services, including civil engineering, services personnel, and FBI agents worked on the project. The explosion demolished the building and construction debris hampered recovery efforts. Medical and dental records also were housed in the collapsed building and were not readily available. Identification processes comprised reviewing dental and medical records, photography, fingerprinting, X-rays, and records keeping. Pre-assembled forensic dental kits greatly aided identification efforts. Within 11 days, 95 percent of the casualties were identified. The remains were returned to the United States through Dover AFB. Ultimately, the team identified all Marines who perished on that day. Challenges experienced during the operation included a lack of adequate space, facilities, and availability of specially trained personnel.[60] As General Ahearn remembered,

> I was the junior brigadier general in all of Europe, but I was assigned the task to recover, identify, and return the fallen Marines to their families. I don't think there was a more ready person to be able to do this. We had to dig all the remains out of those buildings and find the medical records and match them up. We put them in body bags and airlifted them back to Frankfurt. There were two brigadiers: I was the young guy charged by the Commander in Chief of Europe to get these guys out, identify them, prepare their remains, put them in their uniforms, and airlift them to Dover AFB. We had national media events in the hangar at Dover for the return of the Marines. My counterparts at Marine headquarters were Brig. Gen. [Carl E.] Mundy, Jr. and Brig. Gen. [James M.] Mead. I still know those guys. Mundy ended up being the Commandant of the Marine Corps. I saw my friend George Robinson [a Marine with whom General Ahearn attended the Industrial College of the Armed Forces (ICAF)] in the face of every one of those Marines we dug out of there…I tried to tell Mead and Mundy that they didn't need to worry about this Air Force guy taking care of their Marines. They needed to stop declaring their guys dead until I got them positively identified and declared. It was very important to establish that kind of rapport, to protect the legal interests of all the families.[61]

1978 Reorganization and the Establishment of AFESC

The Air Force Chief of Staff activated the Headquarters, Air Force Engineering and Services Agency (AFESA) on April 8, 1977 at Kelly AFB, Texas, in response to FY77 manpower guidelines to reduce overhead by streamlining and consolidating organizations.[62] The new agency consolidated specialized technical services to make better use of existing managerial and technical resources. AFESA's mission was "to provide highly specialized Engineering and Services management, technical assistance, and operating support to all Air Force organizations." Its goals included "responsive support" to base, major command, and Air Staff managers in resolving problems; "improved effectiveness and efficiency" in all Air Force Engineering and Services organizations; and "effective interaction with Air Force research and development, logistics, management evaluation, education, and training functions."[63]

Components assigned to AFESA included portions of the Air Force Civil Engineering Center (AFCEC) at Tyndall AFB, Florida; the three Air Force Regional Civil Engineer (AFRCE) Offices in Atlanta, Dallas, and San Francisco; the Air Force Commissary Service headquartered at Kelly AFB, Texas; the food service and laundry/dry cleaning functions of the Air Force Services Office from Philadelphia, Pennsylvania; and, the Air Force Mortuary Services Office located at Bolling AFB, D.C.[64] One other major addition was the Civil Engineering Maintenance, Inspection, Repair, and Training Team (CEMIRT) (headquartered at Peterson AFB, Colo.) on December 1, 1977. CEMIRT was formerly assigned to the Aerospace Defense Command. AFCEC's civil and environmental engineering research and development functions did not become part of AFESA. They were transferred to the Armament Development and Test Center at Eglin AFB, Florida, and designated as the Civil and Environmental Engineering Development Office (CEEDO). This new organization remained collocated with AFESA at Tyndall, with Lt. Col. Donald G. Silva as CEEDO commander.[65]

General Thompson, the Air Force Director of Engineering and Services, served as AFESA Commander as an additional duty, while each commander or chief directed and administered the mission responsibilities of their respective units. The Air Force Commissary Service commander was the AFESA deputy director. One goal of the new organization was to implement a Management by Objectives program to accomplish planning and control functions.[66] AFESA was a short-lived organization. As General Wright recalled, it was "mostly a paper organization…created in 1977 simply to put all the functions coming together on one chart."[67] On June 30, 1978, Headquarters AFESA was redesignated as Headquarters, Air Force Engineering and Services Center (AFESC).[68]

When General Gilbert became the Director of Engineering and Services in July 1978, he already was involved in a far-reaching reorganization of the Air Staff Directorate of Engineering and Services and the creation of AFESC.[69] From 1962 to April 1978, oversight of the Directorate of Engineering and Services at Headquarters U.S. Air Force was under the Deputy Chief of Staff, Programs and Resources. Overnight, the directorate was realigned under Logistics. As General Gilbert recalled,

> Without my knowledge, [it was] announced one morning after a meeting with the Chief of Staff…that we [the Directorate of Engineering and Services] were going to be switched to LE, Logistics, and that my maintenance division, real estate, and family housing and Services would be moved to Tyndall [AFB, Florida], out of the Pentagon, as part of the movement out of the Washington area. I said, "Hey! I can't operate that way! Everything that those outfits do happens in coordination with the total Air Staff. We'll do nothing but spend our time between here and Tyndall coordinating things that we need to implement." Well, you're still going to do it. That's when I made the decision that if that much of my activity was going to be located at Tyndall, I had to have some pretty high-level leadership down there to bring it together and make it operate from a field environment, and yet keep up a staff image and a coordinated staff position with that much distance between us. That's when I moved the general officer slot down there and put General Wright in charge.[70]

Brig. Gen. Clifton D. Wright, Jr., who took command of AFESC at Tyndall AFB in mid-August 1978, recalled his orders:

> General Gilbert gave me clear marching orders. In his opinion, the Air Force Civil Engineering Center (AFCEC), which he had once commanded when it was located at Wright-Patterson, had lost touch with the real world. It had become a bureaucratic self-serving organization that had lost sight of the fact that its mission was to support engineer requirements in the field. I remember Gilbert telling me, "It's lost its focus as the CEC. We need to reestablish our credibility with the MAJCOM civil engineers." Jud Ellis had begun to work the problem but it needed MAJCOM involvement and support. Having just come from two MAJCOM assignments, I knew exactly what he meant.[71]

General Wright fully supported the idea of transforming Engineering and Services into a more customer-based, activity focused on improving the working and living conditions of Air Force personnel as implemented by Generals Thompson and Gilbert. General Wright had previously been deeply involved in the initial integration of Engineering and Services at USAFE under General Thompson. He continued to implement the initiative as Deputy Chief of Staff, Engineering and Services, at Headquarters SAC in Omaha, Nebraska. When General Wright became the first AFESC Commander in 1978, he was concurrently designated Deputy Director of Engineering and Services, subsequently becoming Director in 1982.[72]

Headquarters AFESC was established as a separate operating agency (SOA) on June 30, 1978 at Tyndall AFB, Florida. The new organization was planned to be fully operational by October 1, 1979 after the transfer of 153 manpower authorizations, comprising 38 military and 115 civilian personnel, was completed.[73] General Gilbert wanted to form an organization that responded to Air Staff needs and the needs of bases and major commands. The organization was planned to be the "focal point for worldwide engineering and services activities that are required to support the day in, day out operations of the Air Force around the world."[74] The AFESC mission statement read:

> The Air Force Engineering and Services Center (AFESC) is a separate operating agency that is both an extension of the Air Staff and a focus for worldwide engineering and services activities.
>
> AFESC guides and assists major commands, bases, and other federal agencies in design of real property facilities; readiness and contingency operations; facility energy; civil engineering research and development; base operations and maintenance; fire protection; real estate acquisition and disposal; environmental planning; billeting; family housing; food service; and other areas which affect the daily operation of the Air Force community and the Air Force mission.[75]

Divisions that transferred to AFESC from the Air Staff included Real Property, Engineering and Construction, Housing and Services, Operations and Maintenance, and Environmental Planning.[76] In addition, six functions transferred from other agencies, commands, and SOAs to join AFESC. These were the AFCEC (redesignated as the Air Force Engineering Technology Office or AFETO) and the Civil and Environmental Engineering Development Office, a component of Air Force Systems Command, already at Tyndall AFB, Florida; the Air Force Services Office from Philadelphia, Pennsylvania, which relocated in July 1979; and the three AFRCE offices located in Dallas, Texas; San Francisco, California; and, Atlanta, Georgia.[77] Most, but not all, of the components of earlier AFESA, transferred to AFESC. The Air Force Commissary Service remained separate from AFESC.[78] Mortuary Services moved to AFESC in 1984.[79]

The initial organization of AFESC comprised eight directorates, four groups, and three offices that reported directly to the commander. The eight directorates were Engineering, Housing and Services, Real Property, Environmental Planning, Operations and Maintenance, Engineering and Services Laboratory, Civil Engineering and Services Management Evaluation Team (CESMET), and Resource Management. The groups were Plans and Analysis, Energy, Fire Protection, and Readiness. The AFRCEs maintained three separate offices (Figure 4.2).[80]

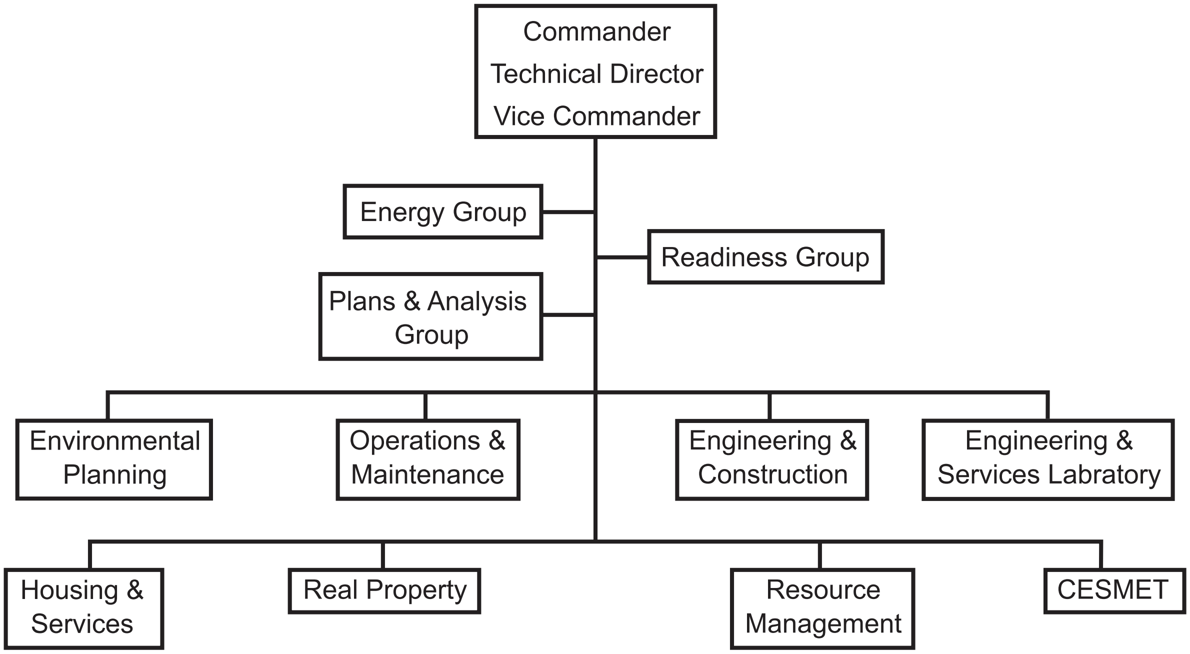
As described by General Wright,

> AFESC was...an extension of the Air Staff…It included parts, and in some cases all, of HQ Air Force Civil Engineering headquarters staff elements. The entire Real Estate Division and the O&M Division moved to AFESC. Services functions from the AFSO in Philadelphia that had been part of AFESA on paper physically moved to AFESC. Mortuary Affairs came [in 1984] from the Air Force Military Personnel Center (AFMPC) at Randolph AFB. Civil engineering R&D also became a part of the Center.[81]

As an SOA whose commander also served as Deputy Director of Engineering and Services, the organization was charged with development of policy for Readiness, Operations, and Services. General Wright expressed the excitement and enthusiasm generated by the formation of the new Center:

> General Gilbert looks upon establishment of this Center in many respects as a fresh new start--a second generation with long-term potential that is virtually unlimited. The Air Force Engineering and Services community we have today is founded on many decisions made in 1947. Beginning with the first Director of Air Installations, we built on that foundation a staff in Washington that has served us well. Today, we are on the threshold of putting together a staff at the Center that will carry us for the next generation.[82]

Figure 4.2 Air Force Engineering and Services Center, 1978



Source: History of the Air Force Engineering and Services Center, 1 January 1978 – 31 December 1978, Vol 1, 3.

A new building was constructed for AFESC at Tyndall AFB, Florida. It comprised 66,000 square feet in three interconnected one-story buildings designed to house 359 people. The $4 million structure was designed by the firm of Sherlock, Smith & Adams of Montgomery, Alabama. The construction contractor was Burns, Kirkley and Williams of Auburn, Alabama. While the exterior of the building was described as "simple, yet distinctive," the interior design was praised for its innovative open plan. Individual workspaces were separated by 62-inch movable privacy panels. The telephone system was a SL-1 Business Communication System, one of the most advanced systems available. Reliable communication with Headquarters U.S. Air Force and other Air Force offices was critical to the operation of AFESC. In keeping with the emphasis on energy conservation, an article in *The Military Engineer* journal noted that the facility was equipped with "an energy efficient variable air volume" air conditioning system and a hot-water baseboard radiator heating system. In addition, all facilities were handicapped accessible. Activity centers were incorporated into the building's interior design. The Readiness Center was a 2,100 square foot, secure area that contained a computer room, a work room, and a control room, with a backup power system. The Readiness Center was designed to operate as a control center during wartime or during national emergencies. Other activity areas included a computer center, a word processing center, and a snack bar. The new building was occupied on September 24, 1978. On July 1, 1982, the building was dedicated to the memory of Maj. Gen. Robert C. Thompson, who had died the previous March.[83]

Air Staff elements and personnel relocated to AFESC were moved as part of an overall initiative to reduce the number of people assigned to the National Capital Region.[84] On paper it appeared workable but in reality for some of the activities it was inefficient and cumbersome. By the end of the first year, General Gilbert convinced his boss that separating certain Air Staff elements between the Pentagon and AFESC in Florida, was an inefficient way to operate. After General Gilbert presented his arguments, his boss answered, "'You're right; move them back.' Just like that. No order, no nothing. I just started moving them back."[85] Some Air Staff personnel assigned to AFESC never actually relocated to Tyndall. In 1979, some people in Engineering, Real Property, and Environmental Planning Directorates

Exterior view of Building 1120, HQ Air Force Engineering and Services Center.

moved back to Washington, D.C., but remained on the books as members of operating locations that were considered part of AFESC. Services functions, with the exception of Family Housing and the Operations and Management Division, remained at AFESC.[86]

By the end of 1979, despite the manpower perturbations, AFESC had grown to an organization of nearly 600 people.[87] The role and mission remained essentially as originally conceived. This included developing civil engineering policy for Headquarters U.S. Air Force and providing technical field assistance to major commands and bases. Major AFESC activities were energy, fire protection, environmental planning, housing, services, and civil engineering research and development.[88] The Readiness Group at AFESC served as the focal point of all readiness issues for the civil engineer organization. The Readiness Group directed and provided readiness training for Prime BEEF, RED HORSE, and Prime RIBS units at both home stations and through specific field exercises. During contingencies and actual war, the Readiness Group activated and operated the Readiness Center in the AFESC building and directed and controlled the deployment of Prime BEEF, RED HORSE, and Prime RIBS units worldwide.[89]

AFESC Emblem

A competition was held to design an emblem to represent the AFESC organization. Calls for submissions occurred during 1978.[90] Elements incorporated into the emblem were collected from many sources. Approved by the Air Force Manpower and Personnel Center on August 13, 1979, the new symbol was designed to reflect AFESC's history and its predecessor organizations, as well as its future worldwide role. The logo was dominated by an eagle's wing, a reference to the historical Air Force civil engineering emblem. The wing supported a globe decorated by a compass symbolizing the engineering field, an atom symbolizing AFESC's research role, an aerospace vehicle demonstrating the integration of civil engineering with the flying mission, and a cornucopia symbolizing the "dedication of AFESC to improving the quality of life for all Air Force personnel, particularly in the areas of subsistence, housing and billeting, and work environment."[91]

The Operations and Maintenance Directorate at AFESC was responsible for maintenance management policies, procedures, and methods to support BCE organizations nationwide.[92] Experts were available for technical consultation and problem solving to assist bases in a variety of technical areas, including airfield pavements, facility and utility corrosion control, water and waste treatment and disposal, and civil engineering vehicle and equipment maintenance management.

AFESC also fielded technical assistance teams that conducted regular inspections in their areas of expertise or assisted bases to solve specific problems. Among these traveling technical teams were the Civil Engineering Maintenance Inspection Repair and Training (CEMIRT) Team, the Corrosion Analysis Team, the Pavement Evaluation Team, the Runway Skid/Hydroplaning Analysis Team, the Runway Roughness Evaluation Team, the Facility Energy Assistance Team, the Food Management Assistance Team, the Bird/Aircraft Strike Hazard team, and the Aircraft Rescue Field Assistance and Evaluation Team.[93]

New projects and programs were continually added at AFESC. In 1981, a Construction Cost Management Group was formed.[94] This group was established to estimate the costs of selected, multi-year construction projects, to conduct independent cost analyses, and to support the overall Engineering and Services budget and appropriations process before the U.S. Congress.[95] A few high profile Air Force construction projects, most notably the Aeropropulsion Systems Test Facility at Arnold AFB, had significantly exceeded budget. The Construction Cost Management Group was officially tasked to:

- Develop a now capability to support independent cost analysis requirements on major construction programs currently on the books and in the early planning stages.
- Support improvement in the construction cost management process.
- Influence the definition and justification for future Air Force construction programs.[96]

The Construction Cost Management Group under Maj. Ed Parkinson and Rita Gregory developed the parametric cost estimating system. Prior to parametric cost estimating, construction project estimates were submitted at the 35 percent design phase. Actual construction was typically several years in the future and the construction costs were not adjusted for inflation. Parametric cost estimating resulted in truer cost estimates for long term projects.[97] The U.S. Congress accepted the use of parametric as a valid cost estimating tool in 1989.[98]

In August 1983, the Product Management Directorate was formed. The mission of this directorate was “to identify, consolidate, assign, and track all requirements and to ensure that related products are acquired and made available to the user in a timely manner.”[99] The group also investigated whether an “off-the-shelf” item would meet required applications. Such investigation was intended to eliminate unnecessary research and development efforts. Within the new directorate were the Requirements Division and the Product Management Division. The role of the Requirements Division was to ensure “that E&S support requirements and limitations are identified as new Air Force operational concepts, weapons systems and equipment are developed.” The role of the Product Management Division was “management of the E&S product acquisitions” with “emphasis…on the systems approach to ensure products are produced in correct quantities and configurations, deployed to the right places and the right time, and are supportable.” This office was instrumental in getting the rapid runway repair sets into procurement, a long-standing problem for the laboratory. [100]

In 1983, the Information Management Systems Office was established.[101] This office was tasked with overseeing the development of improved automation and software programs to provide managers at all levels, from the base through the major commands to Headquarters U.S. Air Force, with effective information and data management needs.[102]

By 1989, AFESC under the command of Col. Roy G. Kennington, a Services officer, employed nearly 900 people at Tyndall AFB and at other locations. AFESC continued to provide headquarters, major commands, and individual bases with technical support throughout the Air Force, perform engineering and services R&D, perform HQ USAF management functions, and provided wartime training to support the deployment of engineering and services personnel worldwide.[103] By 1988, AFESC was organized into seven directorates: Information Management Systems (renamed Computer Applications and Development in 1989), Operations and Management, Housing and Services, Engineering and Services Laboratory, Readiness, Fire Protection, and Cost Construction Management.[104]

Engineering and Services Laboratory

The Engineering and Services Laboratory (ESL) was established as an AFESC directorate in 1979 following the transfer of the Civil and Environmental Engineering Development Office (CEEDO) from Air Force Systems Command in November 1978.[105] AFCEC had been assigned to the Air Force Systems Command (AFSC) since 1972, but was reassigned to AFESA on April 8, 1977 and transferred to AFESC in 1978.[106] AFCEC was renamed the Air Force Engineering Technology Office in October 1978, before being inactivated on March 15, 1979.[107]

In 1976, under AFCEC, the Research and Development (R&D) program was staffed by 216 persons with a budget of just under $6 million. AFCEC was responsible for the following R&D activities: "facility-related corrosion prevention and control, airfield pavement evaluation, site selection surveys, aircraft crash rescue and fire protection assistance and evaluation (added in 1976),…snow and ice removal system evaluation,…pavement surface effects (skid resistance, roughness), surveys,… evaluation of foreign technologies and materials related to air base facilities, bird/aircraft strike hazard surveys, airfield noise contour programs, environmental planning assistance (added in 1975),…and conducting R&D programs in air base survivability/vulnerability, environmental engineering, air mobility, aerospace facilities, and facility energy conservation/supply."[108]

When AFCEC was assigned to AFESA in 1977, the R&D mission remained under AFSC.[109] AFSC established CEEDO as a detachment at Tyndall to eliminate redundancy and promote better communications and cooperation with AFCEC. On November 15, 1978, CEEDO was realigned with AFESC, and subsequently inactivated as a separate entity on November 17, 1978.[110]

ESL continued the R&D programs initiated under AFCEC and AFSC. The stated purpose of ESL was to perform "research, development, test and evaluation in civil engineering" in the areas of civil engineering, environmental quality technology, and facilities energy.[111] ESL's primary objectives were:

> to develop methods and techniques for detection and control of environmental pollutants, and environmental assessment and impact evaluation of Air Force operations; to improve Air Force civil engineering, especially in the areas of geotechnical engineering, aircraft contingency launch and recovery surfaces, protective facilities construction, air mobility systems, and aircraft fire fighting crash/rescue equipment; to develop the technology base and hardware for application of alternate energy resources to Air Force facilities, conservation of resources, and development of technologies to recover materials and/or energy from refuse at military installations.[112]

A major research focus between 1977 and 1986 was air base survivability and operability during war. While the TABVEE program during the late 1960s addressed the protection of vulnerable aircraft from attack, launching platforms, i.e., the runways, were recognized as the next most vulnerable Air Force assets for attack during war. Acknowledging that aircraft are useless if they cannot be launched from damaged runways, the Air Force established the goal to "provide the capability to launch tactical aircraft within five minutes after an attack and to prepare a suitable expedient runway that can sustain limited operations within an hour."[113] ESL conducted R&D and testing programs on aircraft contingency launch and recovery surfaces, such as pavements and repair materials to make pavement repairs; aircraft and tactical shelters; corrosion control and repair of aircraft fuel systems; and, recovery of airbase equipment, power, and facilities after attack, including aircraft fire/rescue equipment.[114] Requirements changed over time in response to several factors, including experiments with the number and size of craters in airfield pavements; triage techniques to prioritize crater repairs; expedient repair techniques; the quality and quantity of materials used in the repairs; determining allowable surface roughness to prevent damage to aircraft from debris; and, working with ordnance issues and in possible chemical and biological environments.[115] Research on this topic had direct application in the field and shaped the training for Prime BEEF and RED HORSE teams to accomplish rapid runway repair and base recovery after attack duties.

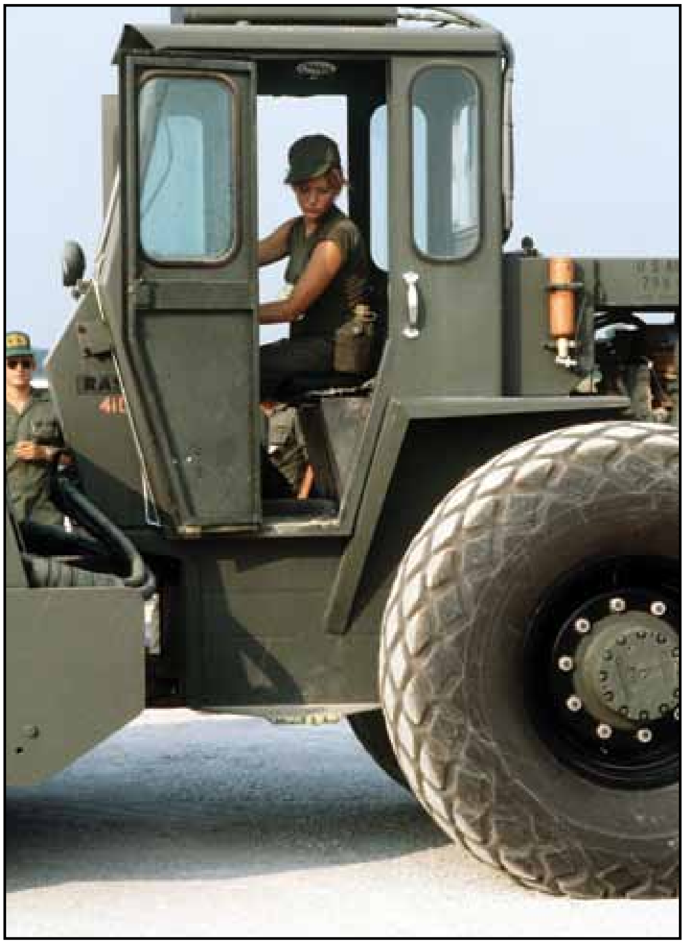
The ESL also supported base-level civil engineering operations and maintenance activities through a variety of programs. Areas of research included corrosion, firefighting, and pavements. In many cases, these studies had direct applications in both normal peacetime operations of air bases and in emergency or readiness situations. Studies of corrosion, for example, had application for current maintenance and repair issues, as well as for maintaining metal components used in similar systems during deployment. Sample corrosion studies included facilities corrosion; hazards of static electricity in petroleum, oils and lubricant systems; and, corrosion prevention in reinforcing steel.[116]

One specialty of the laboratory was airfield pavements—their construction, maintenance, and rapid repair.[117] ESL continued the former organization's research studies into the properties of soils and asphalt and concrete pavements.[118] By 1983, the Air Force maintained approximately 210 million square yards of airfield pavements that required approximately $35 million annually to maintain and repair. More than 90 percent of existing pavements were over 20 years of age and had exceeded their design life. By the early 1980s, a concerted effort was underway to inventory and evaluate the properties of airfield runway surfaces to establish baseline data, such as load-carrying capacity. Until 1983, that assessment required the physical collection of pavement and soil cores that were sent to ESL for analysis of strength and physical properties. This process required shutting down use of the pavement surface, but non-destructive methods for evaluating airfield pavements were developed in the 1980s.[119]

Fire protection was another major research emphasis. The purpose of the program was to develop, test, and evaluate firefighting agents, equipment, and vehicles to support the Air Force's 13,000 active and reserve component firefighters. Firefighters were responsible to control not only structural fires, but also for crash and rescue activities, including extinguishing aircraft fires and rescuing pilots. This research directly supported base operations, as well as prepared firefighters for deployment. Some projects under development in 1982 included the development of a lighter, smaller self-contained breathing apparatus capable of working in a chemical weapons environment.[120] The new breathing apparatus was operational by 1984.[121]

With the ban of asbestos in 1981, the Navy and the Air Force Aeronautical Systems Division developed new clothing for firefighters. The new clothing comprised a chemical weapons undergarment, a Kevlar outer garment, and a communications helmet.[122] In addition, a new training simulator was under development to train firefighting and crash rescue skills. The simulator was based upon pilot training simulators with state-of-the-art audio, visual, motion, and smoke to train firefighters in fire suppression, vehicle operations, and tactics.[123]

ESL also managed the Air Force environmental quality R&D program, which was conducted by 10 different laboratories funded through the Air Force Systems Command. The Environics Division of ESL was tasked to provide:



A1C Susan Miller operates a 10-ton roller used to compact crushed limestone during a simulated runway attack Prime BEEF exercise at North Field, 1980.

- Methodologies and techniques for pollutant characterization
- Environmental assessment of these pollutants in transport, interaction and their ultimate fate
- Control methods to ensure peacetime mission accomplishment.[124]

The environics program centered on assessing environmental effects related to weapons systems. The program pinpointed potential issues and options in three major research areas: "hazardous wastes, Air Force fuels, and assessment technology."[125] A database was developed to track the past and present locations of hazardous materials on Air Force installations, to record their toxic effects, and to support the development of techniques to reduce and/or treat these materials in a cost-effective and environmentally friendly way.[126]

By 1980, three Air Force organizations conducted R&D to support civil engineering: the Air Force Office of Scientific Research, the Civil Engineering Research Division of the Air Force Weapons Laboratory, and the Engineering and Services Laboratory. Civil engineering R&D funds were programmed each year through the Research and Development Requirements Council, which reviewed current and planned Air Force R&D efforts related to Civil Engineering and Services needs. Funding for ESL generally came from several sources, including ESL designated funds, special projects funded through major commands, collaborative participation with other Air Force research organizations and AFESC, and O&M to support bases with specific services. In 1981, ESL received funding through the Air Force Systems Command to support ongoing R&D work in post-attack launch and recovery, air

Aerial view of the 9700 Research and Testing Area, Tyndall AFB, Florida.

base survivability, pavement technology, and firefighting techniques. This funding source provided \$250,000 in FY81 and \$500,000 in FY82, with an additional \$450,000 added in that year for work in air base survivability. By FY83, the program funding was projected to rise to \$1 million.[127] Funding for programs for R&D related to firefighting technology alone rose from \$150,000 to approximately \$2 million between 1980 and 1984. In 1984, a group of Air Force research laboratories, comprising the Air Force Weapons Laboratory, the Air Force Armament Laboratory, and ESL, worked together to raise their funding profile from \$1 million in FY82 to an anticipated \$12 million by FY87.[128]

On October 18, 1984, a groundbreaking ceremony was held to start construction on a new laboratory at Tyndall AFB, Florida. The cost of the 33,000 square-foot building was projected at \$3.5 million. Dignitaries at the groundbreaking included the Director of Engineering and Services Maj. Gen. Clifton D. Wright, Jr.; AFESC Commander Col. Jerry A. Smith; Col. Charles Lau, Deputy Director, Science and Technology, Headquarters Air Force Systems Command, and U.S. Representative Earl Hutto, who encouraged the plan through U.S. Congress.[129] *Air Force Engineering & Services Update* described the groundbreaking ceremony,

> AFESC commander, Col. Jerry A. Smith directed the digging of the traditional first "shovel" of earth. A 20-ton multipurpose excavator, adapted from "off-the-shelf" inventory by the E&S laboratory for use in the rapid runway repair program, took a huge bite of earth with a gold-painted bucket.[130]

In 1986, ESL vacated five World War II-era buildings that it had occupied since AFCEC days and moved into Building 1117 at Tyndall AFB, Florida.[131]

Groundbreaking for Building 1117, Engineering and Services Laboratory, Tyndall AFB, Florida.

Air Staff Reorganization in the late 1980s

By 1988, the Directorate of Engineering and Services at USAF Headquarters in the Pentagon was organized under the director, deputy director, and associate director. AFESC, the Air Force Regional Civil Engineers (AFRCE), and the Plans Division reported directly to the director's office. Two additional deputy directors served under the director. The Deputy Director for Construction oversaw the Construction Division, the Engineering Division, and the Environmental Division. The Deputy Director for Programs oversaw the Programs Division, the Housing and Services Division, and the Real Estate Division.[132]

In January 1989, the Installation Development Division (AF/LEED) was formed by combining missions previously assigned to the Construction (AF/LEEC), Engineering (AF/LEEE), and portions of the Environmental (AF/LEEV) Divisions. The new division was aligned under Mr. J.B. Cole, the Deputy Director for Construction. The purpose of the change was to integrate all elements of the new division, and focus them on improved delivery of quality planning, design and construction products. The five branches of the new division were Program Management (AF/LEEDM), Policy (AF/LEEDP), Planning (AF/LEEDX), Facilities (AF/LEEDF), and Engineering (AF/LEEDE) (Figure 4.3).[133]

By April 1989, General Ahearn established a new liaison division (AF/LEEL) to champion programs from AFESC at Tyndall AFB. Previously, most AFESC programs had been championed by the Plans and Programs division (AF/LEEX). Program responsibility remained at AFESC. The key function of the new liaison division was to expedite and coordinate administrative packages on behalf of Center program managers. The new division was headed by Col. William R. (Reed) Craig. The deputy division chief, Harry R. (Hank) Marien, also headed the AFESC Privatization Implementation office (AFESC/DEQ).[134]

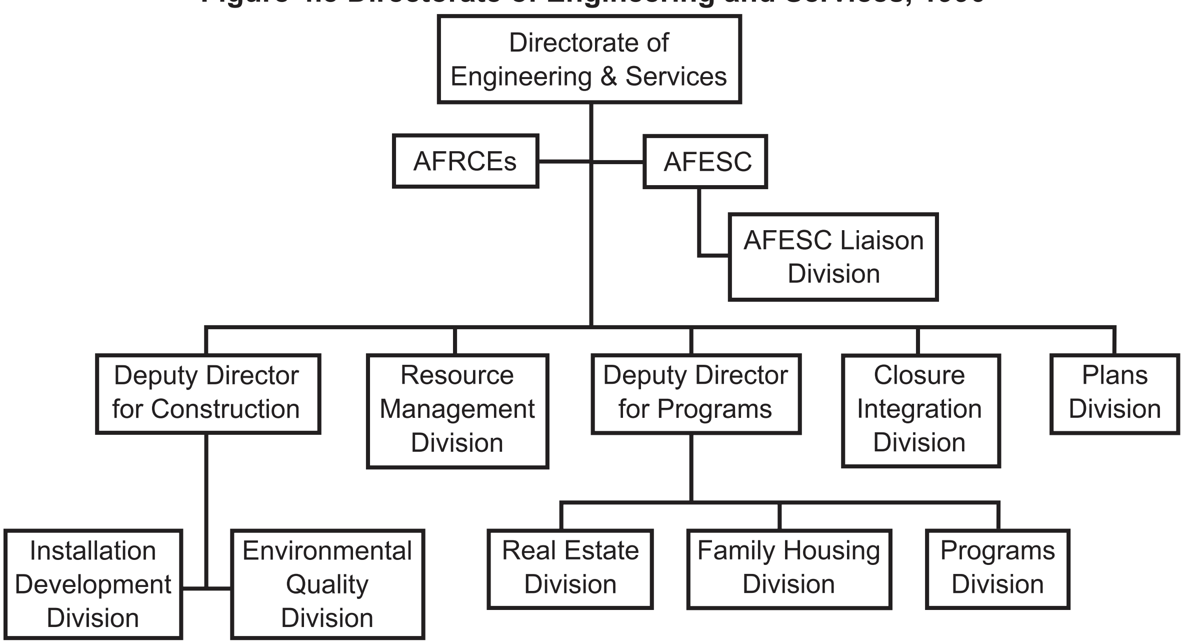
As base closure actions accelerated in the 1980s, General Ahearn established the Closure Integration Division within the Air Force Directorate of Engineering and Services in December 1989 as the single focus for Engineering and Services responsibilities associated with the closing of Air Force bases and the realignment of missions resulting from the closures. The 17 people (3 officers and 14 civilians) in the division developed overall functional guidance for the subsequent disposal of real property for which the Secretary of the Air Force had been delegated federal property disposal authority and implemented the policies of the Air Force Secretariat in disposing of these installations. Further, it integrated the development of policy and ensured management oversight for the interrelated actions of military construction; environmental cleanup; and real property disposal. It ensured supporting activities of environmental impact analysis properly interface with realignment and closure actions. The division also had program approval authority for the allocation of Base Closure Account, MILCON design, and construction funds appropriated by Congress, and coordinated with the Secretariat Comptroller on funds apportionment and allocation. Lt. Col. (later Brig. Gen.) David M. Cannan headed the division.[135]

Another one of General Ahearn's first actions was to recognize the contributions of the non-commissioned officers to the civil engineering and services organization. General Ahearn created a Chief of Enlisted Matters position on the Engineering and Services staff at the Pentagon and named CMSgt. Larry R. Daniels to represent the enlisted force on the Air Staff. General Ahearn also declared 1989 as "The Year of the Chief." From the early days of his Air Force career, General Ahearn had learned to value and respect his chief master sergeants, who truly were leaders, and tapped them to help formulate engineering policy and to enhance grass-roots motivation and communication.[136] General Ahearn and CMSgt Daniels began holding conferences with the chiefs which evolved into the Chiefs Council.[137]

Programming Budgets and Cost Programs 1975-1990

During this time period and throughout its history, one of the primary roles in the office of Director of Engineering and Services was to assemble the Military Construction (MILCON) and operations and maintenance budgets for the Air Force and to defend the MILCON budget before the U.S. Congress.

Figure 4.3 Directorate of Engineering and Services, 1990



Source: Maj. Gen. Joseph A. Ahearn, "Protectors of the Environment," The Military Engineer, January-February 1990, 11.

CMSgt Larry Daniels, Civil Engineering's first Chief of Enlisted Matters, 1989-1992.

During the late 1970s and early 1980s, the Air Force worked to standardize programming procedures for the budget.

Programming involved developing fully justified budget requests and supporting those requests to fund Air Force personnel, weapons systems, activities, construction, and operations and maintenance of facilities. Air Force funding sources included the Military Construction Program (MCP, later named MILCON), non-appropriated funding (NAF), P-341 funding covering unspecified minor construction, and operations and maintenance (O&M) funds that then included repairs up to $300,000. Prior to 1974, the Air Force assembled and prepared MCP funding requests in two year cycles. After 1974, the budgeting cycle for MCP funding expanded to three years. [138]

Congressional oversight of MCP funding requests received increased scrutiny. During the late 1970s, the U.S. Congress began to require greater justification for construction projects. This included cost benefit analyses and project designs developed to a 35 percent completion level to ensure that projects were viable and that cost estimates were sound. Multi-year projects received additional Congressional scrutiny since the potential for cost overruns was greater.[139]

Preparing an Air Force MCP for Congressional approval was a multi-layer review process. The basis of the budget was the Program Objective Memorandum (POM).[140] As described by then-Colonel Joseph A. Ahearn, "In [the POM,] we program over five years the needed resources to fulfill our missions. There is one essentiality that must precede programming and that is good planning. Secondly the POM is the stepping stone to the budget. There is a general rule in the Pentagon that is noteworthy. The rule is 'If it ain't in the POM, it ain't in the budget.'"[141]

The section of the POM developed by the Programming Division of the Directorate of Engineering and Services comprised project requests submitted by individual bases to their major commands. On the individual base, the BCE typically managed from 40 to 60 percent of the base's funds.[142] The major commands assembled all of the funding requests from the individual bases under their commands and added project funding requests for projects and programs of their own to enhance their Air Force missions. The major commands then submitted their packages to the Programming Division in

Engineering and Services at the Pentagon. Prior to 1980, projects selected for inclusion in the budget were decided at the Pentagon level. Major commands, then individual bases, were informed about approved projects several months after the budget passed Congress. Once bases were informed that projects were approved, the scramble began to finalize construction designs, award contracts, and expend the allocated funds.[143] During the early 1980s, direct participation was opened to the major commands within the budget process. [144]

A significant portion of the Air Force budget was spent on weapons systems and aircraft. Monies for construction programs that improved the quality of life for Air Force personnel had no priority until General Gilbert incorporated them into the budget process. To have funds available for personnel support programs, General Gilbert decided that the funding for the construction of weapons facilities should be included in the total cost of the weapons systems and not be incorporated into the budget assigned to the Directorate of Engineering and Services. This was a major change in the way funds were allocated and it allowed General Gilbert to fund more quality of life programs. As General Gilbert recalled,

> When I became Director, the process was that the Director of Programs, who sliced the pie for the Air Force budget in the Pentagon, would come up to Civil Engineering when he got the POM and say, "Okay look, I can give you as your part of the pie $750 million." That happened to be an exact figure that was put to me one time. I said, "I've got that many requirements in three major commands, let alone 12. "Well, that's all you're going to get." Okay, fine. Then they would go into the meetings in the program office, which was called the Air Staff Board, to divide up what we were going to do with the Air Force budget and how much. By the time I provided the funds out of my $750 million to bed down new weapons systems, which we were buying by the gross, I had nothing left to replace or to build anything for people. I said, "Hey, this is no good."
>
> I called Bud Ahearn into the office. He was the head of my Programs shop and a member of the Air Staff Panel that made these decisions, because there was always a facility tail that went with the beddown of a weapons system. I said to Bud, "Look, we're not going to do that anymore. I'm going to the head of Programs, and I'm going to tell him that I'll take his $750 million, but anything that requires a facility beddown tail is programmatic. If you're going to buy a system, the program's got to carry the whole thing. Not my pot." By golly, I sold that idea.[145]

The POM was subject to rigorous internal review on four levels through the Air Force Board Structure. The budget requests were divided into subject areas and reviewed by one of 14 panels comprised of knowledgeable people in the subject area. At this level, projects were reviewed for need and relevancy to the Air Force missions. The major commands advocated directly for their budget requests in front of individual subject panels.[146]

In August 1984, a new review panel was instituted to review all requests that included the construction of facilities. The panel also reviewed all budget requests for MILCON, family housing, and real property maintenance activities. The Facilities Panel evaluated "near-term" and "long-term" obligations. One panel chairman remarked, "There's nothing that the Air Force does that doesn't require real estate, a platform, utilities, or a building of some kind—and to get the funds for the 'something,' you have to pass the review of the Facilities Panel."[147]

If a project request survived the panel reviews, it was submitted for review to the Air Force Program Review Committee (PRC). The PRC developed the POM that integrated all major command priorities. The POM was presented to the Air Staff Board and reviewed by senior Air Force personnel, who evaluated all the items against Air Force priorities. In 1982, these priorities included: recruiting, training, equipping, motivating, and retaining Air Force personnel; the strategic weapons systems program; readiness and sustainability of deployed forces; and, modernizing tactical air forces. The finalized POM then was reviewed by the Air Force Chief of Staff, followed by the Secretary of the Air Force, and finally by the Defense Department's Defense Review Board. The budget was then submitted to the U.S. Congress.[148]

One of the purposes of the POM was to incorporate project planning on the major command and base levels. Working with a five-year plan, items that were not funded in the current year could become next year's priorities. If money became available during the budget year, then projects originally planned in the upcoming year could be funded in the current year. BCEs were encouraged to plan for this possibility and to have projects designed in case funding became available. BCEs then worked with procurement and contracting personnel to use funds within frequently demanding schedules dictated by fiscal year deadlines. With careful planning and coordination with appropriate personnel, the BCE could pull project plans off the shelf to match available funding.[149]

As summed up by then-Colonel Joseph A. Ahearn, "the POM is the expression of the resources to fulfill the mission of the Air Force…We measure projects against two questions. The first question is 'What does it contribute to airpower?' The second question is, 'What does it contribute to the productivity of the Air Force workforce?"' General Ahearn's advice for the BCE on the major command and base levels was to create a good base development plan, to identify solid project requirements, and to have a sound five-year investment plan.[150]

Cost Programs

Under General Wright's leadership, several new approaches were implemented to strengthen execution of MILCON programs and projects. Special management teams for large projects were formed to facilitate communication among team members during the life of the project. The AFRCE offices assigned responsibility for large projects to a single point person. On the base level, comprehensive base plans were produced to ensure that solid planning preceded project programming. Training was offered to engineers responsible for programming to enhance descriptions of project requirements and to improve project books to guide designers. In an effort to enhance the ability to estimate costs on multifaceted projects, an independent cost estimating/analysis capability in the Construction Cost Management Group was established at AFESC. In addition, a variety of construction contracting methods were analyzed and tested. For example, a cost-plus-fixed-fee contract was used to construct the Peacekeeper assembly, surveillance, and inspection building in Wyoming, while a turnkey contract was used to construct a major Air Force command and control center expansion.[151]

The Directorate of Engineering and Services also invested in automated costing systems. General Wright recalled that during the Reagan Administration,

> The Air Force was scrambling to get several major MILCON weapons systems programs going in 1982 and 1983, and the momentum continued through my time as Director. We had to work closely with our design and construction agents, and we had to have systems to manage the programs. Information technology and related management systems were just emerging. We began development of an automated program to track and monitor costs and schedules. Maj. Jim Owendoff and Capt. Rusty Gilbert were our action officers to get the automated PDC (Programming, Design, and Construction) program developed. I think it replaced CECORS [Civil Engineer Contract Report System] and was the forerunner of automated management programs in place today.[152]

Cost estimating was greatly improved through the assistance of the Construction Cost Management Group formed at AFESC in 1981. The primary mission of the group was to forecast and monitor construction costs, particularly on large, high profile projects. A few high profile Air Force construction projects, most notably the Aeropropulsion Systems Test Facility at Arnold AFB, had gone significantly over budget. An assessment of Air Force construction procedures revealed that management of large Air Force projects often was fragmented among several organizations. Calculation of total project costs was complicated since funds were provided through several methods, including multiple line items in the MCP. For example, the Over-the-Horizon Backscatter Radar program was funded through a contract to construct the weapons system, while support facilities were funded through the MCP. The costs for installing the Ground Launched Cruise Missile were shared between NATO and MCP funds. On the other hand, control of the Missile-X program was consolidated in the Ballistic Missile Office, which had the opportunity to oversee project costs for both weapon system development and ground support facilities. The goal of the new Construction Cost Management Group was to provide engineering programs with sound fiscal cost estimating to assess true project costs. Rita Gregory, a member of the group, developed a parametric cost estimating system that provided greatly improved estimates than older methods of estimating costs based on 35 percent of the design.[153]

Program management remained a challenge throughout the 1980s. When J.B. Cole transferred to the Pentagon as a Senior Executive Service member in the late 1980s, he remembered,

> The deputy [Director of Engineering and Services] was then-Brig. Gen. Joseph A. (Bud) Ahearn (Maj. Gen., USAF, ret.). He said, "I want to ask you one question, 'Why can't we execute a military construction program?'" I thought the answer was easy. But, I looked at the process. What I found was programming ahead of planning, no rules written down, and inconsistencies from program to program. So, I had to write a book called Program Management in the Air Force…it will help young engineers in the predesign conferences come up with a successful effort. Behind the book is the decision to hold people responsible for execution. Yet, I found we had never taught a course in program management at AFIT. So, I developed a course and started teaching it. We also urged the Congress to change the law, because it was not working. I think that the eloquent testimony by General Ahearn, who presented the briefings, helped to change the law. We were calling for design to be at 35 percent complete two years prior to competition. There was no way a project could remain static and unchanged in an environment where the leadership might change twice during the time before we got construction underway.[154]

As a result of the leadership of innovative military and civilian personnel, efforts were made to institutionalize better budgeting procedures and cost estimating on all Air Force levels from the Pentagon, through the major command, and the bases. Ground rules and manuals were written to codify these procedures; follow up procedures were established to monitor and control construction costs that supported the increased construction budgets of the early to mid 1980s.

Wartime Manpower Studies during the 1970s

In 1976-1977, two manpower studies to assess wartime personnel requirements and the force structure were conducted. The results of these and follow-on studies caused the Civil Engineering and Services organization to reshape the composition and assignments of civil engineer squadrons. Peacetime jobs of military personnel at home stations were matched with their war time roles when deployed. The Air Force completed the first of the two studies between summer 1974 and spring 1976. In 1977, the Department of Defense conducted a Joint Contingency Construction Requirements Study that examined personnel requirements for the Joint Chiefs of Staff, all four Armed Services, components of the Unified Commands, and the Specified Commands. The purpose of both studies was to identify "manpower/logistical requirements to support the war scenario" of a conventional war in Europe against the U.S.S.R and to determine "deployment/employment" of deployed fighting personnel.[155]

Based on the initial results of those studies, the Office of the Secretary of Defense (OSD) proposed to decrease the numbers of military personnel across all services. At that time in 1977, manpower in Engineering and Services was authorized for about 80,000 civil engineering personnel and 15,000 in Services.[156] Of the 80,000 in civil engineering, about one half were military and one half were civilians. Of the military personnel, about 10 percent were assigned to mobile contingency teams with the remainder forming the resident base recovery force of Prime BEEF. Air National Guard or Air Force Reserve accounted for approximately 30 percent of the force. Services included approximately 6,000 military and 10,000 civilians.[157] The Civil Engineering organization personnel reduction in force was proposed at 25,000 military personnel, which would have ended the Prime BEEF and RED HORSE activities. The cuts also were supported by a 1957 DoD directive that assigned responsibilities to construct Air Force facility requirements during war to the Army Corps of Engineers.[158]

Maj. Gen. William D. Gilbert recalled the beginning of the manpower study,

> Out of the clear blue sky one day we got a program document from [Office of the Secretary of Defense] OSD that cut 25,000 civil engineers…I asked, "What's this? What brought this about?"...I only had about 35,000 military and they were going to take out 25,000, which would have taken out all of the RED HORSE squadrons and most of the people at the bases, and it would have totally done away with the Prime BEEF concept, the RED HORSE concept, and any other concept for us to support ourselves, with our own military forces.[159]

General Gilbert disputed the findings of the study before OSD, and was told that the Army claimed to have sufficient personnel to perform all wartime construction. General Gilbert reminded OSD personnel that the Army had promised similar support in Korea and Vietnam, but had not been able to deliver that support. Therefore, the Air Force had formed Prime BEEF and RED HORSE units to provide the construction support during war deployments. Gilbert made the following request to the OSD personnel,

> I said, "I'll tell you what you do. Tell the Corps to show you the forces." I said, "Let me tell you where the Corps' forces are; they're notional forces just like they were in Vietnam, and just like they were in Korea. There are spaces in the Reserve and Guard that have no bodies in them. They couldn't call up people. If they called up the spaces they'd be empty spaces…They don't have enough people to support themselves, and we've never gotten a day's support out of them." You know what? I successfully argued that to the extent that OSD said, "Okay, we will temporarily set aside this reduction in force, and we will task the [Joint Chiefs of Staff] JCS to do a study on construction requirements for each of the services, and then we'll see if the Corps has sufficient assets to support you out of what they actually have and what they're going to need." I said, "I'll buy into that." [160]

After this meeting, General Gilbert initiated a study throughout the civil engineer organization to shape the Prime BEEF teams into actual working teams that purposely trained together and to match peacetime job descriptions to war time job requirements. He tasked a team to analyze projected civil engineer needs under the current war plans and to match those needs with the actual career specialists required when groups of 50, 100, or 150 personnel deploy. The study team also was tasked to quantify the requirements for military personnel needed to remain in the United States to operate home bases. While many home station tasks would be performed by civilians and contractors, some installations required the presence of military personnel due to security concerns. General Gilbert proposed, "Let's reconfigure the teams in terms of how much Air Force deployment takes place, looking at how many Prime BEEF members we need to deploy with that size force, based on the war plans. We did that. We found out some very interesting things during that process. Before, we had a lot of people on teams, but we didn't have the right ones, and we didn't have them in the right number." [161]

Selected civil engineer findings concerning their manpower allocations included the following:

- Civil engineering forces were not structured properly and insufficiently mobile;
- Few of the right kinds of people were performing tasks at their home stations that could translate into critical wartime tasks in war time situations;
- Current equipment and material posture was not able to handle the job;
- Technological efforts to solve key wartime roles, such as rapid runway repair and repair of bomb damage after attack, were not progressing at a sufficient rate due to current fiscal constraints.[162]

One weakness identified through the studies was the configuration and composition of the force structure available for deployment, which was quantified by unit type codes (UTCs). UTCs were used to categorize all job skills required during deployments and then matched to peacetime jobs at home stations. This process ensured that all military personnel were matched with a direct wartime/mobility mission and assigned into appropriate Prime BEEF teams for the wartime scenario as defined by the JCS.[163]

When the JCS study came out, it supported General Gilbert's findings for manpower requirements, stating "The Air Force not only needs what they've got now; but they don't even have enough to support the total war plan. The Corps has its hands full to take care of themselves, so we're going to rewrite the DoD directive and give the Air Force its own responsibility for heavy maintenance, as they call it, and light construction."[164] In addition to restoring the 25,000 personnel that were cut, civil engineering gained a RED HORSE squadron in the Reserve.[165]

The responsibilities of overseas Air Force construction during deployments was redefined through DoD Directive 1315.6 issued on August 26, 1978. Under this directive, the Secretary of the Air Force was authorized to deploy Air Force civil engineer troops for the following overseas missions:

- Emergency repair of war damage to air bases.
- Force beddown of Air Force units and weapon systems.
- Operations and maintenance of Air Force facilities and installations.
- Crash rescue and fire suppression.
- Construction management of emergency repair of war damage and force beddown.[166]

The realignment and restructuring of peacetime to wartime roles of military personnel affected the entire civil engineer organization. The director of Civil Engineering and Services successfully defended civil engineer manpower authorizations. Overall readiness of each military civil engineer personnel was improved by assignment to a wartime role on a Prime BEEF team. Now every military personnel had a wartime role to train for, while maintaining their skills through their peacetime job at their home installations. Training for readiness became an important goal for all civil engineer military personnel.

The revised structure of Prime BEEF was implemented during 1979 and new regulations covering the Prime BEEF program and base recovery planning were issued by the Readiness Group of AFESC. The civil engineer components in the Air Reserves and Air National Guard also were organized into

Prime BEEF teams for the first time. Criteria to evaluate all Prime BEEF teams using operational readiness inspections (ORIs) were crafted and distributed to major commands. A similar program was established for Services, known as Readiness in Base Services, or Prime RIBS, with 274 teams being formed by the end of 1979.[167]

Throughout the 1980s, the challenge to civil engineering manpower requirements continued as the Directorate of Engineering and Services strove to maintain the proper balance of civil engineering and service personnel. The civil engineer organization was continually prepared to prove that its military personnel were either part of readily deployable contingency forces or required stateside within "strategic withhold" categories. Job positions not classified as readiness or strategic withhold were likely candidates for either contracting out or "civilianizing."[168]

Quality of Life Programs

Under the leadership of Generals Thompson, Gilbert, and Wright, the Directorate of Engineering and Services placed great emphasis on quality of life issues for Air Force personnel. Although the first mission of all Air Force personnel was to support readiness and survivability of the USAF, these generals focused their efforts on the Air Force people who make the organization run and who deserved improved living and working conditions. This was particularly relevant with the adoption of the all volunteer forces in 1973. The Armed Services competed for recruits with the private sector and, in order to retain recruits, paid more attention to their welfare. During these years, improvements were funded to upgrade and to enhance dormitories, food service in dining halls, recreational facilities, and personnel support services.[169]

General Gilbert sought acceptance of Quality of Life programs in Air Force budgets and in policy statements.[170] In 1978, the following mission statement for the Directorate of Engineering and Services was issued: "Provide Civil Engineering and Services forces ready to respond to all contingencies. Efficiently and effectively maintain, repair, construct and manage Air Force real property facilities and provide quality services to insure [sic] USAF operations are fully supported." The mission statement was supported by five Engineering and Services Goals:

- Improve readiness capability,
- Improve energy effectiveness,
- Increase productivity,
- Improve customer service and satisfaction, and
- Improve the quality of life.[171]

Quality of life issues were a particular passion for General Gilbert. He convinced Air Force leadership to dedicate a portion of appropriations for projects that enhanced the "Quality of Life" on bases. As he recalled,

> My first effort was to try to make a decent place to work, live, and play…We coined the phrase "Quality of Life," Bud Ahearn and I did. I convinced the leadership that if we could not provide a decent place for people to live, work, and play, we were not going to have a contented force…We're in peace time now. We're getting kids that come from big, nice, $100,000 or $200,000 homes, with a private bedroom, and putting them in a…dormitory with two or three people to a room… You're not going to retain them. And if you send them to work in a place that's broken down, with leaks…they're not going to be happy…Have happy workers and you have great workers, you have more skilled workers and more productivity.

> Dining halls were running down, so I said, "For the Quality of Life program let's start off with \$65 or \$75 million, and we dedicate it to that. We won't buy anything else with it except things for people." We were supported in the idea. Then it began to grow; it began to catch on.[172]

As the Air Force portion of the Military Construction Program (MCP) began to increase during the early 1980s, General Gilbert was able successfully to increase funding for Quality of Life initiatives.[173]

General Gilbert was particularly proud of increasing the space allotment in dormitories from 135 to 150 square feet per person. Initially the Army and the Navy told the U.S. Congress that there was no need to increase the living space in their services. But General Gilbert persisted and eventually won approval from the U.S. Congress to increase space allotments per person in dormitories.[174]

Another initiative under the Quality of Life program was the introduction of the *a la carte* system in the dining halls. As General Gilbert explained,

> we were recruiting a group of young people who were fast food buffs. They didn't understand the concept of a full dinner or lunch at noon. That was hamburger time. So, we started a program to modernize the dining halls. In some cases, if it was not cost-effective we'd build a new dining hall. The Services people were in on the design, because they were the ones who had to operate it. They had operating experience, and they knew where things ought to fit and how it ought to fit together. Then we started the *a la carte* program to cater to the forces we were recruiting from civilian life…My experience everyplace I went when I had Services, was that 90 percent of the young people I saw coming into the dining hall would walk to the short-order line.[175]

These improvements made Air Force installations better places to live and work and responsive to the needs of its military personnel.

Project IMAGE

Project IMAGE was conceived as a three-year programmatic review of the Civil Engineering and Services organization at all levels, from the base through the major command, to headquarters and to all agencies and centers. IMAGE stood for Innovative Management Achieves Greater Effectiveness and was the civil engineer portion for a service-wide functional review directed by the Office of the Secretary of Defense in 1981. The DoD-wide functional review was conducted in response to Office of Management and Budget (OMB) Circular A-76 that directed Federal agencies to realize organizational efficiencies by contracting out services.[176]

The main purpose of Project IMAGE was to analyze the Base Civil Engineering organizational structure for products and services. The goal was to define clearly civil engineering roles and missions to support Air Force fighting capabilities through the efficient and effective use of peacetime resources. The product areas identified for base civil engineering and services were: "Ensure Readiness, Provide Real Property, Sustain Real Property, Provide Utility Service, Establish Physical Environment, Provide Fire Protection, Provide Non-Real Property Service, and Provide Technical and Management Services."[177] The ultimate goals of Project IMAGE were to retool the organization to accomplish its mission more effectively, to ensure that all processes and procedures were results oriented, and to seek ways to work smarter, more efficiently, and less labor intensively. The major emphases of the program were on results management, manpower efficiency, and removal of constraints to productivity by reducing regulations to allow creativity and innovation by base managers.[178] The implementation of flexible procedures allowed for innovative management at the BCE level to increase productivity.[179]

One result of Program IMAGE was revision of the mission statement for civil engineering and services. The new mission statement was established by spring 1984 as follows, "Provide the necessary assets and skilled personnel to prepare and sustain global installations as stationary platforms for the projection of aerospace power in peace and war."[180] This mission statement emphasized that essential role of civil engineering in the Air Force fighting capability.[181]

Another major accomplishment of Project IMAGE was an assessment of the general purpose vehicles used by civil engineering personnel. A comparison of BCE organizations with private sector groups revealed a personnel-to-vehicle ratio of one-to-one in the private sector, and a ratio of more than three-to-one within BCE operations. The low amount of vehicles required crews to share, which resulted in wasted time and unnecessary planning. In fall 1984, Booz, Allen & Hamilton was contracted to assess the needs of work crews and to address the necessary steps to create ideal personnel to vehicle ratios. The study showed that the CE workforce lost approximately $24 million worldwide in productivity on an annual basis. Civil engineers and Air Force Transportation personnel jointly developed a General Services Administration (GSA) leased vehicle program because purchasing additional vehicles would take several years. GSA distributed the first 300 vehicles to seven bases. A follow-on contract with Booz, Allen & Hamilton studied those seven bases and noted that productivity improved consistent with the earlier study's conclusions and virtually eliminated transportation-related non-productive time. However, by 1988, GSA vehicles were being returned because of a lack of base-level O&M funding for the continued lease of vehicles.[182]

Architectural Design Excellence

General Wright, educated as an architectural engineer, was particularly proud of his emphasis on the importance of comprehensive base planning and quality architectural design. General Wright formed an architectural design committee and established a senior-level design consultant at Headquarters U.S. Air Force to review interior designs. The first Air Force-wide conference on design was held in 1982 at the Air Force Academy.[183] General Wright recalled,

> I preached it just about everywhere I could and focused on several priority initiatives. One of the first was to stress comprehensive planning and quality architectural design at the AFRCEs and MAJCOMs. We needed a vehicle to carry the message to planners and architects throughout the Air Force and promote and culturally embed an appreciation of good planning and design. To that end, I created an Architectural Design Committee in 1982 consisting of several reserve officers who brought tremendous experience from their civilian professions. I asked them to review designs of major projects and to create planning assistance teams that would be available to visit bases at the request of the commander or BCE to provide professional planning advice. Architectural compatibility and historic preservation was high on their priority list.[184]

Architectural, community design, and quality of life issues also were supported at the major command level. During the period between 1979 through 1985, Tactical Air Command (TAC) under the leadership of General W.L. Creech and General Ellis invested heavily in the aesthetics and functionality of buildings and in quality of life improvements. Col. Marshall W. Nay, Jr., who joined TAC in 1978, summed up the overall theory of General Creech and General Ellis, "If an Air Force person will take pride in their workplace environment, especially if they've toiled to create it—i.e. the Air Force Self-Help Program—they'll take pride in themselves and the products and services they produce." TAC maintenance crews were working in outdated aircraft hangars with outdated tools. TAC elected to fund major building upgrades to improve working conditions and to update tools for maintenance crews. Its efforts stretched beyond tools and outdated buildings. The improvements included interior cleanup, which created a sense of increased pride among personnel, improving morale and enhancing services. As General Ellis stated, "We made the relatively expensive bet that if we gave the maintenance folks an appropriate place to work and quality tools to work with, we would have gone a long way in establishing the right aircraft maintenance mental attitude."[185]

When General Ellis joined TAC in 1979, $8 million were allocated for Engineering and Services contract programs. During the next few years, funds allocated for Engineering and Services contracts at TAC increased dramatically, rising from $33 million in 1980 to $99 million in 1982. Without increased staffing, General Ellis oversaw a workload that rose from 100 active projects to over 500 projects.[186] With increased funding, TAC leadership improved the working conditions for security police, and munitions maintenance, transportation, and Services personnel. In addition, base improvements were made in barracks, housing areas, and personnel support facilities.[187] General Creech, the TAC commander, took a personal interest in reviewing architectural details of construction programs and even introduced an exterior painting scheme, known as "Creech brown," for all TAC bases that was intended to unify the overall appearance of the bases. General Creech firmly believed that architecture affected a person's wellbeing as well as work efficiency. He was well known for his motto "quality in everything you do."[188]

The emphasis on architectural design and interior design was formalized at TAC with the establishment of the TAC Design Team in 1980. The design team comprised "a multidisciplinary group of architects and engineers dedicated to providing in-house design capability to the [Deputy Chief of Staff] DCS for Engineering and Services at TAC." The office had two parts: Architecture/Engineering Branch and the Interiors Branch. The team had the capabilities to design all types of facilities throughout the command. The group operated like a commercial architecture and engineering firm, but with faster response times and a working knowledge of Air Force facility requirements.[189]

Another indication of the importance of design excellence was the Air Force Design Awards program. It began in 1976 to recognize architectural design excellence and was part of the Federal and DoD Design Awards program. General Wright felt the need to "re-energize and jazz up" the Air Force Design Awards Program during his tenure, with support from Mr. Robert A. Stone, Air Force Assistant Secretary for Installations. He also developed a close working relationship with the American Institute of Architects.[190]

Air Force design philosophy was propounded in Air Force Manual 88-43 entitled "Installation Design." Issued in 1981, the introduction of AFM 88-43 stated,

> Military installations should provide efficient and pleasant physical environments conducive to attracting and retaining skilled and motivated personnel. A military installation conveys a visual image in terms of its design character and organization that can be either clear, logical and attractive or cluttered, confused and disoriented. The design, location and maintenance of individual elements such as buildings, roads, parking lots, signing and planting, affect the quality of the visual environment. Each of these elements should be functional, attractive and harmonious with its surroundings to create an environment that enhances the capability of installations to support their missions and fosters pride in and commitment to military service.[191]

Investment in the built environment paid dividends on all levels. Statistics developed at TAC in the 1980s indicated a direct correlation between the quality of working and living conditions and mission capability. As summed up by General Ellis, "The ultimate result is that our folks work and live better and there is a measurable improvement in the condition and useful life of our real property assets. Again, our facility improvement efforts have had a positive effect on attitude, quality of the workplace and productivity."[192] Even more impressive was the affect Creech's procedures had on readiness. According to a 2005 Air Force Magazine article on the accomplishments of Creech,

> The most obvious result of Creech's methods was a turnaround in readiness indicators. The TAC accident rate dropped from one every 13,000 hours to one every 50,000 hours. Sortie rate was perhaps the most important of Creech's basic metrics. TAC's average per-aircraft sorties rose from 11 to 21 per month. In effect, he had doubled the number of available aircraft. The number of aircraft out of commission for maintenance declined by 75 percent.[193]

This had a large impact on performance and readiness.

Installation Excellence Award

President Ronald Reagan created the Commander-in-Chief Installation Excellence Award in 1984. The award recognized the exceptional accomplishments of the people in each military service and DoD who operated and maintained the installations. Five recipients were chosen annually. Kadena AB, Japan, received the award in 1985, becoming the first Air Force base to win the award.[194]

Joint Program Participation

Throughout this time period, joint participation, defined as serving with other components of the U.S. Armed Services, and combined actions, defined as serving with armed forces of other nations, continued for the Air Force. Within the Department of Defense (DoD), the functions of the Air Force, Navy, Army, and Marines were individual yet complementary. By the early 1970s, efforts had been made within the services to tailor forces to meet a variety of perceived threats to national security. Each service had components for strategic offense and defense, as well as general purpose forces and support forces. The role of the Joint Chiefs of Staff in this aspect of Total Force was crucial; the organization planned and managed the employment of all the U.S. Armed Forces.[195]

During the 1980s, the United States relied more on allies and friendly nations to supply personnel, funding, and resources to the mutual common defense. Allied strengths and capabilities were assessed along with U.S. capabilities to quantify the Total Force of all Allied countries to fight against a common enemy.[196] Combined exercises provided a chance for the U.S. forces to work with military from other countries and to assess their ability to organize to win in conflict situations.[197]

Air Force civil engineers were encouraged to serve in areas with exposure to joint programs with other U.S. services and to serve in overseas commands in Europe and the Pacific. Service at a joint activity was recommended as part of career development for civil engineer military officers. One example of this service included eight Air Force civil engineer officers who began a two-year exchange program with the Army and the Navy in 1973.[198] In 1979, 44 military jobs were classified as joint or combined positions. A joint staff position typically comprised two or more U.S. services and included 13 positions at DoD and the Joint Chiefs of Staff in the Pentagon. Among the Unified Commands were one position with the Atlantic Command in Iceland, four positions in the European Command, eight positions in the Pacific Command, and ten positions in NATO.[199]

In 1986, joint participation among all the U.S. Armed Forces was strengthened by the U.S. Congress after the passage of the Goldwater-Nichols Act (Public Law 99-433). This law was enacted as a result of Congressional investigations after the U.S. invasion of the tiny island nation of Grenada. On October 25. 1983, approximately 7,000 U.S. forces along with 300 military personnel from neighboring

Caribbean nations participated in the invasion. The reasons given for the invasion were to depose a Marxist-led coup, rescue the islanders, and rescue American medical students. U.S. forces encountered approximately 1,200 Grenadan forces and 800 Cubans. Fighting lasted three days and the last U.S. forces left the island by December 1983. The Air Force provided military airlift and close air support by the Air National Guard and tactical wings.

While the invasion of Grenada should not have been challenging for U.S. forces, the action highlighted inter-service organizational and planning problems. The Goldwater-Nichols Department of Defense Reorganization Act of 1986 (Public Law 99-433) addressed these problems through restructuring and streamlining the chain of military command.[200] The Joint Chiefs of Staff became an advisory body to the U.S. President, but no longer had direct charge of operational forces. The Joint Chiefs of Staff, the Air Force, and the major commands retained the responsibility for training and equipping personnel; when deployed, military personnel, regardless of service affiliation, were under the authority of unified combatant commands. This radical change in the command structure allowed unified combatant commanders full control over components represented by all U.S. Armed Forces without having to negotiate with individual Services Chiefs for units and personnel. In addition, the law established policies to encourage officers to participate in joint duty assignments.[201]

Maj. Gen. George E. Ellis, Director of Engineering and Services between 1986 and 1989, eloquently expressed the new reality of the concept of jointness,

> Our doctrine, force structure, and operational concepts…must be developed within realistic budgetary and political constraints which dictate jointness—a common purpose and shared resources. Our combat engineering capability must be a team effort—a team composed of Air Force, Army, Navy, and host nation engineer forces, and the civilian engineering industry. This industry includes designers, constructors, and base maintenance contractors, all of whom provide a civilian composite that is and will be critical to successful war fighting…The theater commander knows the importance of keeping air bases operating and has agreed to assign Army units to help Air Force engineers.[202]

General Ellis concluded,

> We are making progress in integrating Army, Air Force, and host nation engineer capabilities. Army and Air Force engineers will work together to beddown deploying forces and restore the air base after an attack. They practice their joint missions today. We also have agreements with our allies that describe the type of engineering support they will provide. These host nations are building the force structure necessary to fulfill those commitments. They can never replace our critical organic engineer forces, but their contributions will help recover the air base quicker.[203]

Private industry partnerships were another aspect of joint programs. The utilization of U.S. and host nation construction industries allowed Air Force engineers to expand their capabilities. The work of private industry partners extended from mobilization to restoration, and included force buildup, long term war programs, and disaster recovery. Their involvement enhanced both operational capabilities as well as logistical support. This partnership is maintained today, as private industries continue the tradition of playing a major role in providing air bases, roads, utility systems, and harbors.

MANAGING THE PEACETIME BASES

Introduction

By the 1980s the Air Force civil engineers operated and maintained 134 major bases and 2,850 smaller installations worldwide. These facilities represented a full range of specialized properties, ranging from operating bases, to logistics bases and depots, to missile installations, communications facilities, hospitals, ammunition storage, and specialized R&D complexes. Improvements on these Air Force installations represented an initial investment of an estimated $18 billion. These installations had reached an average age of 30 years by 1982.[204]

The Civil Engineering Squadron (CES) was the base-level organization responsible for the operation and maintenance of bases. Base civil engineers commanded the CES and oversaw the civil engineering mission on the base level. Specific responsibilities charged to the CES included:

- Maintain in the most economical manner all active property (or structures furnished in lieu of real property) to a standard that prevents deterioration beyond that which results from normal wear and tear, and inactive facilities to a standard commensurate with reactivation requirements (e.g., dispersed operating locations).
- Provide fire prevention and protection engineering services to prevent loss of life and property at all installations.
- Support civil and air base disasters and emergencies, using the personnel and material resources of civil engineering as necessary to save lives, mitigate human suffering, and minimize damage.
- Provide forces to recover air bases damaged by natural disaster or enemy attack.[205]

Approximately 102,000 personnel were assigned to Civil Engineering and Services in 1982; this number rose to 114,000 by 1985.[206] Base civil engineering organizations ranged in size and complexity commensurate with the size and mission of the installation. At McClellan AFB, California, an Air Force Logistics Command base, for example, the BCE managed 880 buildings and additional facilities. Led by a military BCE, the CES comprised 300 military personnel and 500 civilians. The CES included 100 firefighters, 90 engineers and engineering technicians, 60 managers and administrators, and over 500 specialists assigned to in-house craft shops.[207]

Prioritization and management of the dynamic workload for base maintenance and repair presented a daily challenge. Protocols for addressing this on-going challenge were defined in *Air Force Regulation 85-1, Resource and Work Force Management* and subsequent revisions. The system defined in *AFR 85-1*, as illustrated at Sheppard AFB, Texas, was managed from a Production Control Center, housing the offices of O&M Chief, a service call room, a work control room, the offices of Chief of Work Control and Schedulers, and a conference room. Work assignments were tracked through a series of charts, maps, and scheduling boards by a staff of secretaries, controllers, schedulers, technicians, superintendents, foremen, work controller, and vehicle schedulers.[208]

Work requests were logged and prioritized through the Production Control Center. Requests were supported both by paper forms and through entries in the Base Engineer Automated Management System (BEAMS). All work requests were programmed into the In-Service Work Plan. Scheduling decisions were finalized at weekly work or scheduling meetings based on project priority and available labor and materials. Work was executed by craftsmen from the various shops in accordance with the comprehensive weekly schedules. Base shops were specialized and represented a full range of construction and maintenance services. Sheppard AFB, for example, maintained the following shops:

Carpenter, Paint, Plumbing, Sheet Metal, Masonry, Interior Electric, Exterior Electric, Power Production, Sanitation, Entomology, Refrigeration, Heating, POL Maintenance, Structural Maintenance and Repair, Golf Course Maintenance, Housing Maintenance, Heavy Equipment, Pavements, and Grounds.[209]

An impressive volume of work was executed through the civil engineering shops, as illustrated by the 1000 job orders and 30 major work orders completed in a typical month at McClellan AFB. These work orders were administered by separate offices dedicated to special construction projects and smaller scale construction projects.

In addition to the day-to-day responsibilities of CES base management, military personnel also maintained Air Force readiness through participation in Prime BEEF exercises. The 26 Prime BEEF teams at McClellan AFB could deploy in under eight hours.[210]

The CES operations were analyzed continuously to improve system efficiencies and customer service. A series of specialized studies, plans, and programs were initiated during the period to enhance management methodologies, to assure the adequacy of staffing levels, and to provide expertise in areas of specific concern to Air Force bases.

One innovation to improve management on the air base level was the Civil Engineering Management Evaluation Team (CEMET). Lt. Gen. David Jones, commander of the Second Air Force at Barksdale AFB, Louisiana, devised the first CEMET in 1971. At that time, Col. Robert C. Thompson served as Deputy Chief of Staff for Civil Engineering. General Jones recognized that 40-60 percent of a base's operations and maintenance funds, excluding civilian pay and facility projects by contract, were processed through, or directly managed by, the Base Civil Engineer. He was concerned with the allocation and management of these sizeable resources. CEMET provided an objective evaluation of how civil engineering resources were managed.[211] As General Wright described it,

> CEMET was a full-time team of five or six specialists led by a civil engineering officer made up of civil engineering, budget, transportation, contracting, and personnel. They visited installations on a pre-announced schedule for a week to evaluate how well BCE functions were performing and how well they were working with other functional areas to support the base mission. The CEMET was not an Inspector General. It was a team that evaluated operations, provided assistance when necessary, and cross-fertilized lessons learned and good ideas from other bases.[212]

The CEMET was adopted Air Force-wide in 1975 after General Jones and General Thompson moved to the Pentagon in 1974. With the merger of Services and Civil Engineering, the team was renamed the Civil Engineering and Services Management Evaluation Team (CESMET). Col. George E. "Jud" Ellis was selected as the first CESMET team leader.

CESMET provided evaluation and consultant services to base level managers to improve productivity, mission support, and the quality of Air Force life. The team comprised specialists in civil engineering, services, budget, procurement, supply, and transportation. By visiting Air Force installations around the world, they helped solve local problems through direct contact with supervisors and subordinates.[213] Perhaps most important, CESMET provided a "fresh look" at how the CE business was being conducted. Between 1971 and 1975, CESMET visited 200 Air Force bases worldwide; another 65 visits were conducted between 1975 and 1977. CESMET was credited with improvements to base-level civil engineer management as well as the promulgation of improved management procedures adopted Air Force wide.[214]

CESMET's findings were published as "tips" in the *Air Force Engineering and Services Quarterly* to "pass along new ways to do the job better."[215] Topics ranged from budget preparation to fire protection training as well as positive approaches to food service management. All organizations in civil engineering and services received 'tips' to improve morale, output, and quality of work. Additionally, individuals and organizations who received certificates recognizing their "Top Notch" work were listed in the *Air Force Engineering & Services Quarterly*.[216]

The CESMET program continued until the mid-1980s under the leadership of General Gilbert and General Wright, who were successive directors of Engineering and Services from 1978 through 1986. As General Wright remembered,

> General Gilbert kept an Air Force CESMET active, and I did the same through the first two years of my tour as Director in the Pentagon. One or two major commands had CESMET teams going. It was strictly voluntary, and unless MAJCOM commanders had interest it wasn't practical. I found it difficult to continue from the Air Staff level and finally realized that to be a useful management tool it had to revolve around a MAJCOM commander and wing commanders with genuine personal interest and participation. It simply wasn't practical from headquarters Air Force level. After consulting with the MAJCOM civil engineers, I decided to shut it down in 1985.[217]

Another innovation to improve civil engineer management was the establishment of the Base Management Action Group (BMAG). In 1976, Gen. David Jones, Air Force Chief of Staff, tapped General Thompson to head BMAG. The main objective of BMAG was to develop an organized, methodical approach to base level problems. As General Thompson explained to his special assistant, then-Maj. Eugene A. Lupia, "we're going to set up a new group. We're going to look at the entire Air Force to try to make improvements in the Air Force."[218] As described by General Thompson,

> The objective [of BMAG] is to determine ways to improve upon present organization, procedures, functions, and policies, where possible, and at the same time, to realize savings in money, material, and people. The Base Management Action Group (BMAG) has been charged to seek out innovations in the way we do business at base level to meet the challenges of increasing personnel costs and budget constraints-while maintaining operational readiness and quality of life.[219]

BMAG comprised 70 to 75 personnel drawn from a variety of departments and disciplines including Charlie Hudson, Lester Henriksen, Henry Collin, and Brig. Gen. (later Gen.) Earl O'Loughlin, future Commander, Air Force Logistics Command.[220]

In April of that year, BMAG issued a concept paper outlining the group's goals and objectives. The paper focused on base planning and management processes. Building on prior accomplishments, the concept paper identified improvements compatible with past successes.[221] Base-level training was among the group's proposals. An in-depth educational program in base planning and management and the creation of a new career field in base plans and analysis were advanced.[222] In 1976, BMAG also proposed merging Services with the Department of Morale, Welfare, and Recreation to the Pentagon. The proposal was rejected by the major command and Air Staff. Other BMAG recommendations included streamlining the organization of specific branches, including:

- Combining Industrial Engineering Analysis and Quality Control Sections to reduce overall manning,
- Combining Real Estate and Cost Accounting Sections and realigning them under the Industrial Engineering Branch;
- Establishing the Environmental Planning Section under Engineering and Construction which was renamed to include Environmental Planning.[223]

BMAG was disbanded shortly after its creation. The impetus for suspending the group was, in part, related to Congressional interest in its findings and possible impacts to Air Force appropriations. In an interview, General Lupia noted that Congress wanted to be apprised of BMAG actions and ideas to adjust the Air Force budget accordingly.[224]

In 1978, the Management Branch of Air Staff published a document entitled the *Base Level Management Plan*, which enumerated a wide range of management options for base-level civil engineering, identified areas of concern, and presented strategies for corrective action. The Management Branch was charged with the mission of overseeing base level civil engineering management policy. In broad terms, the plan identified base level management goals and objectives in relation to base-level concerns. Management Branch personnel identified 52 separate concerns, organized them into 15 categories, and prioritized them into a manageable plan. Personnel throughout Engineer and Services were asked to join action agencies and to assist in solving the concerns. Action plan agreements were developed for each concern based on the analysis and suggested solutions.[225]

Advances in Automation

Computer technology and data automation offered tools to further enhance civil engineering performance. Computer automation and its integration into BCE operations supported increased demands for efficiency on the base level in keeping with the overriding theme of the period, "doing more with less." The Air Force recognized the potential for computer technology and was an early proponent. Introduced in 1967, the Base Engineer Automated Management System (BEAMS) became the primary program to manage real property and facility records ranging from construction dates to data on repairs and maintenance activities.

Implementation of BEAMS on the base level proved problematic during the mid to late 1970s. As in the case of many early data automation systems, BEAMS often was cumbersome. As a result, BEAMS system was never adopted widely as a base-wide management system, despite several modifications.[226] Both General Gilbert and General Wright recalled the difficulties implementing BEAMS at the base level. General Wright learned about BEAMS while he was Deputy Chief of Staff for Engineering and Services at Headquarters USAFE 1974-1975 and recalled,

> I was able to gradually shift my attention from Services back to the O&M business where we were attempting to implement base-level production control center procedures, as well as the Base Engineer Automated Management System (BEAMS). That was my first exposure to the world of automated management systems…we knew that automated systems were the wave of the future and struggled to get the system on line. The worst part of it was volume. The reams and reams of computer-generated data and reports that the system created were virtually useless to the poor civil engineers working to keep bases glued together. I think BEAMS came to haunt every Air Force civil engineer, but it was the beginning of automation in our business.[227]

Despite initial difficulties, computer technology was proven as a powerful, cost effective, and labor saving tool for data management. General Ellis, the Deputy Chief of Staff, Engineering and Services at Headquarters Tactical Air Command (TAC), spearheaded the second generation of automation.

During his five years at TAC, General Ellis supported adoption of the Wang minicomputer as the data management and tracking tool for TAC's burgeoning construction program. When General Ellis arrived at TAC in 1979, $8 million was allocated for civil engineering and services contract programs. Funds increased dramatically during the next few years and reached $99 million in 1982. During the same period, Military Construction Program budgets rose from $60 million to over $200 million and non-appropriated funds increased from $6 million to $15 million. General Ellis faced a workload that grew from 100 active projects to over 500 projects without increased staffing.

General Ellis' first priority was to address work load management on the base level. He recalled, "I was convinced—had been for years—that managing 3,000 job orders per base per month could not be done effectively with a stubby pencil. I knew that the BEAMS system could not do the job." General Ellis' evaluation of BEAMS was insightful. The system's utility was limited to managing the past; it did not support planning or logistics for future work.[228]

"When I'm out on the road, I like to go look at the hoppers where you put the job orders. Have you ever watched the foreman come in and pick through and choose the ones he wants to do? The ones that nobody wants to do get old and musty; while we get around to doing some of those job orders, we forget that each one represents a customer. It's a shame. Then, if you go to one of the shops, look in the second drawer, left side, and pull it open you'll find old job orders. I've won more bets by picking the second drawer left side. WIMS will change the way we do business, but not the way computers often do. We are going to automate the way we do business today, then we are going to get involved in new and better ways to use the computer."

Maj. Gen. George E. "Jud" Ellis, 1986 [229]

TAC's adoption of minicomputers occurred during a period of major advances in computer programming. While BEAMS had required computer specialists years to develop programs useful at the base level, General Ellis found that the Wang minicomputer could be programmed in a matter of days. User-friendly computers enabled base level staff to input data and to generate useful management reports very quickly. General Ellis' strategy for computer adoption was based on hands-on demonstrations of the hardware and software to gain staff acceptance. To ensure computer access, one terminal was provided for every three to four employees as a shared work station. General Ellis reported,

> I didn't force the terminals on anybody. I said, "Use it if you want to." A most interesting thing happened. We put the computer on-line on a Wednesday. It's usually lonely in my office on Saturday and I like it that way. The first Saturday after we turned the computer on, there were four people in my office wondering why the computer wasn't on. So, now we turn the computer on…. It has become an extension of how they do their job.[230]

Several significant advantages were realized through the adoption of the new computer technology at TAC. Access to current data was perhaps the greatest of these advantages. The system accommodated continual updates. Current data now were accessible in real time rather than on a quarterly basis. Data were not only current, but also easily shared among personnel with access to the system. Shared data led to improved communication and greater interaction among branches and divisions. Finally, reports that once took days to compile were generated in minutes using the computer.[231]

Computer technology and automation also supported services programs at the base level and had particular application in the food service and billeting—programs that were reliant on accurate inventory and real time data. As General Ellis noted,

> The Services information requirements are as important as the Engineering requirements…. The Services guys on my staff got started fast, perhaps faster than the Engineers. They found real utility in the system. There was a food service report that took two people and eight days to complete. It was never correct. The

> computer takes the same report and does it for them in less than 20 minutes; and, when they get done with it, it's right.[232]

General Ellis was a vocal advocate for the integration of computer technology and civil engineering in the Air Force. When speeches initially failed to spark interest among his fellow civil engineers in the TAC system, he resorted to demonstrations at the Worldwide Engineering and Services Conference realizing that the best way to sell the new system was to demonstrate its capabilities.[233]

Automation also had strong support on the headquarters level. Between 1980 and 1982, senior Engineering and Services personnel initiated the Information Requirements Study to project future needs and to develop a long-range data automation plan for the organization. Future demand for automation was identified in all aspects of engineering design and construction, programming, operations, budgeting, fire protection, energy consumption, housing, feeding, and billeting.[234] The results of the Information Requirements Study were the genesis of the Engineering and Services Information Management System (ESIMS). ESIMS was envisioned as a computerized umbrella system capable of accommodating civil engineering and services software applications to support all levels of the organization, from headquarters to major command-level to base-level. The system ideally would allow for application interface and facilitate data transfer throughout the chain of command. The development of the ESIMS was included in the 1983 strategic plan and programmed into the five-year funding plan.[235]

At the Air Staff and major commands, a series of software programs was developed to take full advantage of the rapidly developing technology. Programs to track and to monitor project funding, contracting, and construction costs included the Civil Engineering Contract Report System, the Design and Construction System, and its later iteration, the Programming, Design and Construction (PDC) system.[236] The PDC was field tested among Air Staff, major commands, and the three AFRCE offices during 1984. Plans were developed to operate the system on new computers using the Work Information Management System (WIMS).[237] Even an automated program for the Engineering & Services Strategic Plan was developed.[238]

Work Information Management System (WIMS)

The base-level computer automation program developed for civil engineering, the Work Information Management System (WIMS), comprised computer hardware, operating system, and software programs. This ambitious system promised automation support to all branches, sections, and functions of the civil engineering organization as well as interface with BEAMS. This latter feature was critical to access data housed on the earlier system. The WIMS system was designed for simplicity of use and to provide access to real time data, flexible data queries, and applications for base level management decisions. WIMS also promised communication between bases, the major commands, and Air Staff over current Wide Area Telephone Service or 1-800 lines and the soon to be implemented Defense Digital Network (DDN).[239]

WIMS was developed and implemented in discrete phases over several years. Software was designed specifically to meet the needs of BCE operations. Examples of the specialized applications included those designed to automate job orders and to support material acquisitions.

The job orders component of WIMS was under development by summer 1981. Pilot tests to automate job orders as a stand-alone application were initiated at Eglin AFB, Florida; Barksdale AFB, Louisiana; MacDill AFB, Florida; and, Columbus AFB, Mississippi. Work stations to access the system were installed in service call areas and in the BCE offices at each base. The new system replaced manual job order logs with computerized logs capable of generating Job Order Form 1879, the standardized form then in use. The system tracked the status of job orders, generated daily work schedules for the shops, and tracked job completion. The system also could be used to track work order requests and to generate work order and design schedules. The pilot tests at the selected bases were successful and a target date for adoption at individual bases was proposed for early 1982, dependent upon approvals by Headquarters AFESC. Air Force-wide implementation of the system was planned for FY83.[240]

The Civil Engineering Materiel Acquisition System (CEMAS), another component of WIMS, was tested at Tinker AFB, Oklahoma, in 1984. This software program was designed to provide inventory control for stock support, maintenance, and repair activities. The application tracked total inventory, generated bills of materials, documented transactions, and generated residue stock lists. The system cut the average time for material acquisition by an estimated 50 percent. In addition, the program supported improved efficiency and better tracking of materials to reduce waste, fraud, and abuse in the inventory and supply system. Data generated by the program enabled base civil engineers to limit on-base materials inventories and to prepare accurate orders to local suppliers.[241] CEMAS was implemented at Air Training Command installations during the late 1980s.[242]

The full WIMS automation system was scheduled for implementation in FY84 at Tinker AFB, Oklahoma; Chanute AFB, Illinois; Misawa AB, Japan; and, Davis-Monthan AFB, Arizona. Expansion of the system to all other bases was planned between 1985 and 1988. The base-level hardware for the WIMS comprised a "CPU (central processing unit) with one million characters of storage capability, a tape drive, one or more disk drives with between 125 to 300 million characters of storage, 30 to 45 terminals, and 5 to 8 printers."[243] By summer 1984, a WIMS prototype was undergoing tests and 28 systems were operating on leased Wang equipment. At Tinker AFB, Oklahoma, 71 computer terminals were installed and all branches of base civil engineering were using the system. Portions of WIMS were installed at Wright-Patterson AFB, Ohio; McClellan AFB, California; Edwards AFB, California; and, the Air Force Academy in Colorado.[244] By spring 1985, 31 leased minicomputers were in operation throughout Air Force Civil Engineering and Services, including at Air Staff, at all major commands, and at nine bases.[245]

Services Information Management System (SIMS)

Automation for Services also was under development during the early 1970s through the early 1980s. The food service's Basic Allowance for Subsistence (BAS) A La Carte (ALC) program was the first to experiment with computerization during their conversion of mess halls to cafeterias. The ALC program was designed to track the purchase of menu items. The ALC collected data at the cash register that characterized each food service transaction. These data were used in planning and inventory control, as well as in tracking sales, volume, and methods of payment. A particularly practical application was the Automated Recipe Cost Calculation System, which monitored costs for ingredients used in standardized recipes on a monthly basis and adjusted prices accordingly at the cash register.[246] This system was renamed the Recipe and Menu Pricing System in 1982.[247] The ALC program was tested in October 1972 at Shaw AFB, South Carolina; in January 1975 at Loring AFB, Maine; and in October 1976 at Barksdale AFB, Louisiana.[248]

In 1979, reports released by the Defense Audit Service and the General Accounting Office illustrated deficiencies in food service programs throughout the entire Department of Defense. Recommendations included in the report were addressed in the development of computerized automation programs. In 1981, a new food service automation system was under development at the U.S. Army Natick Laboratories, the facility responsible for DoD food service research and development. The new system, Automated Food Service Operations System (AFSOS), incorporated numerous features to improve inventory and production control, to integrate menu planning, to reduce waste, to incorporate accounting data, and to generate a variety of standardized Air Force accounting forms. In addition, the AFSOS system also identified and tracked customers through magnetic strip meal cards.[249] Magnetic meal cards were read by the cash register scanners more quickly than manual meal cards that required signature verifications.[250] A prototype trial at Seymour Johnson AFB, North Carolina from September 1982 to February 1983 proved the system to be undersized and slow; however, lessons learned from the initial test-run were incorporated into later systems. The trial of AFSOS also proved that automation was a key to improving efficiency and cutting down on costs.[251]

An Automated Billeting and Reservation System (ABARS) based on commercial hotel systems was tested in 1982 at Eglin AFB, Florida. The system supported front desk staff in reservation and housing functions. Although this stand-alone program was designed for a single base application, the system saved money and illustrated the efficiency of automation in assigning and tracking government quarters.[252]

Although successful computer applications were developed to support specific program areas in Services, little attention had been paid to developing a comprehensive hardware and software package. By 1984, a program incorporating lessons learned from earlier computer applications and testing programs was under development. The new program, known as the Services Information Management System (SIMS), could be folded into a single procurement by virtue of shared hardware with its civil engineer counterpart, WIMS. Proactive planning reduced hardware acquisition costs and assured compatibility among the computer systems used at the bases and major commands.[253]

SIMS was built from scratch in 1983. A team of Services specialists representing base personnel from seven commands was assembled to identify the requirements of each area of Services. The Tiger Team also included members from the Air Force Data Systems Design Center and members of Headquarters AFESC. The group met for 90 days at Tyndall AFB, Florida. Working long hours without break, the focused team emerged with the basic system design for SIMS. The system automated a vast array of labor-intensive administrative functions in food services, billeting, furnishings management, linen exchange, mortuary affairs, administration, and Prime RIBS. The final refinements to the system were added by the Data Design Center and Headquarters AFESC staff.[254]

By December 1983, the billeting application was completed. Individual records management for each room in base lodging and contract quarters was at the core of the billeting program. The program tracked space availability, reservations, registrations, check outs, and housekeeping.[255] By 1984, program modules were under development for Mortuary Affairs, Prime RIBS, and food service.[256] A proto-type SIMS was installed on a Wang minicomputer at Davis-Monthan AFB, Arizona in December 1984. Furnishings software was the first module installed, with billeting, mortuary affairs, Prime RIBS, linen exchange, and administration applications added shortly thereafter.[257] The test at Davis-Monthan AFB was completed in 1985.[258]

The hardware chosen to field WIMS and SIMS was the Wang mini-computer. In 1983, PACAF installed a new Wang VS-100 to support management of its burgeoning construction program.[259] In September 1984, the Directorate of Engineering and Services received Air Force approval to acquire hardware to support the Air Force Mini-computer Multi-user System and the WIMS/SIMS programs. The request for proposals for hardware acquisition was released on November 29, 1984.[260] Bids were closed on April 1, 1985.[261] Validation of vendor proposals occurred between April and August 1985 followed by live demonstrations of hardware and software by responsive bidders.[262] On January 24, 1986, the contract for the Air Force Mini-computer Multi-user System was awarded to Wang Laboratories.[263]

TAC initiated an aggressive implementation program beginning at Shaw AFB and Davis-Monthan AFB that same year.[264] By summer 1986, 33 WIMS and 9 SIMS systems were ordered and training on the new systems had begun.[265] In 1987, WIMS was installed at twelve additional TAC bases, while SIMS was installed at five bases.[266] At ATC, 12 of 13 WIMS systems were installed by December 1989 and 11 of the SIMS systems were funded fully.[267] By the end of 1990, the 115th SIMS computer system was installed at Lackland AFB, Texas. The Lackland AFB system was the largest in service, with over 150 workstations and with telecommunications links to over 30 remote locations. By 1992, the last of the 116 SIMS systems was operational.[268] The final accounting for the SIMS hardware acquisition was over $23 million.[269]

In addition, work stations connected to WIMS also provided access to a variety of technical databases maintained by other agencies and private industry. The accessible database included the

Air Force Environmental Model and Data Exchange, the Forest Management Information System, the Environmental Technical Information System, and Paver, a data base for base pavements.[270]

In 1990, the Air Force Management Engineering Agency, in cooperation with AFESC, conducted a study on the impact of implementing WIMS on the base level. The purpose of the study was to analyze the impact of WIMS on base civil engineering operations. Seventeen bases participated in the study. Thirteen bases completed questionnaires on the WIMS program, while investigators conducted on-site surveys at four additional bases. Investigators found that, across the board, WIMS had improved productivity, customer service, and mission support. One advantage of WIMS was its adaptability and its ability to meet the demands of individual civil engineering organizations. The study concluded, "The WIMS decentralized software development concept has been successful because the users have a direct and immediate impact on applications they enhance or develop. The software has continually evolved and it will continue to improve because the users continuously infuse new and better ideas."[271]

The drive to realize the advantages posed by emerging computer technologies continued in pace with the Air Force-wide efforts for automation. By the late 1980s, the Air Force also was investing in personal computers configured in local area and wide area networks. As Maj. Gen. Joseph A. Ahearn remembered,

> [General Ellis, Director of Engineering and Services from 1986 to 1989] had a remarkable competency when it came to management. He was the first to see the value of information technology in civil engineering. He understood coding and the architectural processes of proprietary information, how to format it, how to program it, and things of that sort. He had a love affair with information solutions. We made the Wang decision, and I believe he and I jointly made the decision to go to PCs when he was still on active duty. What was going on in my era was implementing the operating strategies that he had crafted earlier, so I would say those implementing strategies for information solutions were incubating in the mid-1980s, and I think Jud retired in 1989…. It was in 1988-1989 that we actually got into implementing the local area network, wide area network, PC driven.[272]

In addition to advances in hardware and networking, attention also was paid to emerging program standards in the fields of engineering, architecture, and services. For example, Computer Aided Design and Drafting (CADD), a commercial software application fast emerging as an industry standard, was tested at the San Antonio Real Property Maintenance Agency, Texas, for application in creating and maintaining base comprehensive plans and facility design. Once testing was completed, CADD was added to the automation arsenal for the civil engineer organization between FY87 and FY90.[273]

Cost Containment: Contracting, Consolidation, and Early Privatization

Additional avenues for "doing more with less" were sought to manage base operations and reduce manpower. Contracting, outsourcing, consolidation, and privatization were explored to stretch financial resources and to maximize personnel effort. An early trial in total outsourcing was illustrated by the 1960 service contract for base civil engineering functions at Vance AFB, Oklahoma. Under the contract, responsibility for all civil engineering work, as well as aircraft maintenance, supply, vehicle maintenance, and other support services was assumed by a private sector contractor.[274] Another early example of base operations by contractors was Reese AFB in Lubbock, Texas. By 1974, this base was operated by Northrop Corporation.[275] The majority of early contracting, consolidation, and privatization initiatives were less comprehensive and focused on discrete functions and programs within base level civil engineering and services.

Areas that were examined early on were supply and food service. Since the early 1970s, ATC and SAC experimented with streamlining supply and procurement processes for base civil engineering. On August 23, 1977, a memorandum entitled *Use of Contractor Operated Stores for Commercial Item Support* expanded the use of private contractors in supply acquisition for base maintenance and repair activities. The Contractor Operated Civil Engineer Supply Store (COCESS), developed by SAC in 1970, was a direct user-vendor contract to purchase supplies as needed, rather than maintaining extensive on-base inventories of materials necessary for facility maintenance and repair.[276] The memorandum established criteria for the types and range of items that could be acquired from commercial sources under new and renewed COCESS contracts.[277] COCESS was later replaced by the Civil Engineering Materiel Acquisition System (CEMAS), under which base shops maintained standardized stock lists and purchased additional supplies from local suppliers, as needed.

Food service was another early target for outsourcing. Contracting out on base food service led to increased demand for expertise in contracting and oversight. In 1977, *Air Force Regulation 146-14* was rewritten to provide revised guidance for Food Service Technical Representatives of the Contracting Officer in contracts and meal coordination.[278] In 1981, *Air Force Regulation 146-14* was reissued to establish policies and guidance to food service officers on food service contracts.[279] Training in food service contract administration was incorporated into the curriculum at Lowry AFB, Colorado "to provide added emphasis on training regarding food service contract and responsibilities of Technical Representatives of the Contracting Officer."[280]

San Antonio Real Property Maintenance Agency

Consolidation of real property maintenance and civil engineering functions in regions containing a concentration of military installations was a concept advanced by the General Accounting Office (GAO) to DoD from the late 1960s. During the late 1970s, DoD tasked the Air Force to establish such an organization in San Antonio, Texas to provide base civil engineering services for Army and Air Force properties in the area. The installations and facilities selected for consolidated services were Kelly AFB under Air Force Logistics Command, Brooks AFB under Air Force Systems Command, Randolph AFB and Lackland AFB under Air Training Command, Fort Sam Houston under the U.S. Army, 22 Army Reserve Centers, Camp Bullis, as well as several nearby DoD recreation areas. In October 1978, the San Antonio Real Property Maintenance Agency (SARPMA) became operational. This industrially funded agency was tasked with providing "professional, efficient, and economical Civil/Facilities Engineering support." SARPMA was responsible for maintenance and repair for all buildings, pavements, and grounds; minor construction; utilities operations; and refuse disposal, custodial, and entomological services for a combined inventory of 5,945 buildings containing over 42 million square feet on 47,000 acres.[281] The objective of SARPMA was to realize substantial cost savings through consolidating personnel, materials, and supplies from five separate organizations into a centralized civil engineer organization.

In its early years, SARPMA faced serious challenges in staffing, work control, automated data management, supply acquisition, and customer satisfaction. Customer relations were an issue and required large amounts of time and effort from SARPMA leaders to overcome negative perceptions. Participating Air Force commanders felt that they had been forced to relinquish control of base civil engineering on their individual installations. Insufficient manpower continuously plagued the organization. SARPMA operated under personnel ceilings imposed by ATC; the agency did not operate as a separate Air Staff agency with separate staffing allocations. Customers continually complained about the lack of responsiveness to work requests and the excessive bureaucracy required to complete work and job orders. Despite a staff dedicated to correcting these problems, investigations by the Air Force, DoD, and GAO throughout the 1980s found that SARPMA failed to deliver the projected cost savings in manpower and materials. A 1983 in-depth analysis by Air Training Command found that

SARPMA, "Was a bad idea which failed to produce the savings as anticipated. The consolidation has created significant management problems, many of which still exist; and the only reason it is working at all is due to the extraordinary efforts of management to make it work, including adding significant amounts of overhead to support the operation." Plans to disband SARPMA were underway in 1984 and completed in October 1989. Based on Air Force experience, the SARPMA experiment in consolidating military civil engineering organizations on a geographical basis was unsuccessful.[282]

By the early 1980s, maintenance and repair costs rose substantially as the Air Force coped with aging facilities. Air Force civil engineers traced the increased costs to the average 30-year age of the majority of Air Force real property. Greater expenditures were required to maintain a state of readiness for aging facilities. Property conditions further were exasperated by deferred maintenance, which contributed to accelerated facility deterioration and major repair. The Backlog of Maintenance and Repair (BMAR) was developed by FY81 to measure maintenance and repair facility projects that were validated and programmed in the Air Force budget for "the prior fiscal year but which had to be deferred due to a lack of resources." The Civil Engineering Contract Report System was the automated system developed at Headquarters to track BMAR projects. With accurate automated tracking, Air Staff was able to justify fully increased repair and maintenance appropriations for future years.[283] Quantifying the number of BMAR projects also contributed to greater use of private sector contractors for base-level repair work to supplement an already taxed base-level work force.

Increased reliance on contractors added new management duties to the civil engineering mission requiring unique and specialized skill sets. Among these new duties were developing statements of work, preparing cost estimates, serving as contract technical representatives, and overseeing quality assurance evaluation/assessments.[284]

By 1985, the terms "privatization" and "third-party financing" entered the vocabulary of civil engineering. Both strategies for cost containment presented technical and substantive challenges. The concepts presented a radical departure from outsourcing and private sector contracting, more traditional methods of supplementing manpower while containing costs. Private financial investment, long-term lease, or real property transfer to the private sector, all privatization possibilities, were complex issues with far reaching ramifications.

The Air Force began to experiment with privatization during the mid-1980s. In 1985, the Air Force announced that it was exploring third-party financing to qualify proposals on a contract to conduct economic analyses, to assess and solve legal and policy implications, and to develop a request for proposal for third-party construction of visiting officers quarters and conference center facilities at Bolling AFB, D.C., and Wright-Patterson AFB, Ohio. Later, Tactical Air Command officials developed a similar project for a visiting airmen's quarters project to house RED FLAG and other exercise participants at Nellis AFB, Nevada. URS Company of Santa Barbara, California, was awarded the contract on January 15, 1985.[285] The first project selected for privatization was development of a hotel at Bolling AFB. The project ran into opposition from the hotel association in Washington, D.C., and the U.S. Congress, and was ultimately cancelled.[286]

The project to develop visitors' quarters and a conference center at Wright-Patterson, AFB, in Ohio, was successful. The project progressed through the planning stages between 1985 and 1989. Groundbreaking on the new facility occurred on April 6, 1989. This private sector development was a joint venture between HAI, Inc., and Vantage Group, Inc., both from Cincinnati, Ohio. Operating under the name of Visicom, the group arranged a 40-year out-lease on government property within the base, and constructed and operated the building at private expense for use by military and civilian personnel on business to the base. Named the "Hope Hotel" to honor Bob Hope, the building opened for business in June 1990. As constructed, the new building provided conference facilities for 850 participants and 266 rooms and a casual restaurant.[287]

Contracting, outsourcing, and privatization realized savings in personnel. Yet the tension between these programs and Air Force need to maintain peacetime personnel levels sufficient to meet the readiness mission continued. As Maj. Gen. Clifton D. Wright, Jr., Director of Civil Engineering and Services from 1982 to 1986, explained,

> The Reagan Administration brought the world of privatization to the Defense Department. Privatization covered a lot of ground, all the way from operation of AFLC [Air Force Logistics Command] depots to contracting civil engineer and food service operations. DoD began to push and direct privatization initiatives that are alive and well today. There was a lot of confusion about privatization in the early days of the program. People didn't really understand what privatization was. Some confused it with outsourcing or contracting out, as opposed to real privatization, which to me means development, financing, and operation, or even ownership by an entity other than DoD. The infamous OMB A-76 document directing competitive cost comparisons for base level activities became a major factor in our business. All the while we were concerned with protecting our blue suit wartime capability, so there were many confrontations and contentious issues surrounding privatization.[288]

Innovations designed to stretch financial resources during the 1980s included "build/lease" and "shared savings." Build/lease was promoted as a new approach to base housing. The strategy eliminated the costs associated with military housing construction and maintenance while meeting military housing needs. Under the process, as tested at Eielson AFB, Alaska, housing was built by private developers who offered the units to the military under lease or rental agreements. This method for meeting military housing demand was authorized under the Military Housing sections of the Military Construction Authorization Act, which was passed on October 16, 1983. Solicitations for bids issued under the build/lease program enumerated the general government housing requirements and construction standards. Solicitations specified the number of units and the number of rooms per unit. All design, construction, and maintenance costs were borne by the developer. Military leases and rental agreements were proposed for 20 years and 15 years, respectively. Under build/lease, the government referred military applicants to the private housing management firm representing the developer. Military tenants opting to occupy the reserved military housing coordinated directly with the private firm.[289] These initial forays into military-private cooperation in military housing foreshadowed later and more ambitious military family housing privatization programs.

Increased reliance on contracting in meeting the base level civil engineering mission led to efforts to standardize and streamline the contracting process. The first project executed under the Simplified Acquisition of Base Engineering Requirements (SABER) program was initiated in December 1986. As noted at the time of its adoption, SABER was a contracting process "that greatly expedites contract execution of BCE requirements by reducing design work and eliminating normal contracting advertising/award periods. It is particularly well suited for reducing the BCE work order and contract backlogs."[290] Indefinite Delivery/Indefinite Quantity Contracts were awarded under SABER that included 25,000 pre-negotiated tasks covering virtually every construction trade. The vehicle afforded economies in scale and streamlined the contracting process. Air Force SABER planners coordinated directly with the base to define the job requirements, selected from the list of pre-priced tasks, and executed purchase orders.[291] SABER generally was employed for construction projects under $200,000 with minimal design requirements; at least 50 percent of the tasks required to complete the project were selected from the pre-priced contract lists.[292] Project lead time was reduced under SABER by eliminating the time required for detailed design review and contract notifications. Work orders for $150,000 typically were in construction in 60 days, while renovation work costing $40,000 was begun in 30 days.[293]

By 1989, SABER contracts were in place at 23 Air Force bases and more than $30 million in construction work was completed using the procurement process.[294] The number of bases utilizing the SABER program grew to 45 by July 1990. Between 1986 and July 1990, $130 million in construction projects were executed under SABER.[295]

Base Closure

Base closure and the reduction in Air Force facilities and personnel were final options in the on-going struggle to contain costs. From the early 1960s until the mid-1970s, the Office of the Secretary of Defense made autonomous decisions regarding the realignment and closure of bases and installations. These decisions initially did not require consultation with the U.S. Congress, the military, or the public. In 1976, the Air Force proposed closing Kincheloe AFB, Michigan; Craig AFB, Alabama; and Webb AFB, Texas, and reducing activities at Loring AFB. Maine. As part of the closure process, the Air Force prepared environmental impact statements, which were filed with the Council on Environmental Quality in compliance with the National Environmental Policy Act (NEPA).[296] No further consultation or approvals were necessary.

Decision making and procedures for base realignment and closure changed in 1977 with the passage of Public Law 95-82. This law mandated that DoD notify the U.S. Congress of all base closings, assess "the strategic, environmental, and local economic consequences" of base closings, and refrain from further action pending congressional comment. No major Air Force bases were closed under the provisions of the law. By the late 1980s, rising base maintenance costs prompted the reexamination of base realignment and closure procedures.[297]

In 1988, the Secretary of Defense chartered the first bipartisan Commission on Base Realignment and Closure (BRAC) under procedures authorized under Public Law 100-526 (October 1988). The bipartisan commission was established to make military-wide recommendations to the Secretary of Defense and the U.S. Congress. Lawmakers then voted to accept or reject the commission's recommendations in their entirety. The first BRAC commission presented its recommendations in December 1988, which subsequently were approved by the Secretary of Defense in January 1989 followed by the U.S. Congress. The Air Force bases slated for closure included Chanute AFB, Illinois; George AFB, California; Mather AFB, California; Norton AFB, California; and, Pease AFB, New Hampshire.[298]

The success of the bipartisan commission led to the passage of Public Law 101-510 *Defense Base Closure and Realignment Act of 1990*. Under this legislation, Congress charged the Department of Defense with compiling a list of bases for closure and realignment, which would be submitted for consideration to an independently constituted commission. This BRAC commission first met in 1991.[299]

Zonal Maintenance

Cost containment, efficiency, and customer service were pursued aggressively in base-level civil engineering organizational structure throughout the period from 1975 to 1990. Operations in the base maintenance and repair shops were one area of the organization that was continually scrutinized to increase efficiency, to reduce costs, to complete maintenance and repair tasks effectively, and to improve customer service. On a typical base, over half of BCE employees were involved in physical maintenance and repair activities. These employees usually were organized into shops by trade classifications. As Harry Rietman recalled of his time in the Maintenance Division,

> There was another group that was concerned with the organization of the base civil engineers. They were continually trying to improve the efficiency of the organization to accomplish the maintenance work at base level. There was the so-called "Find It, Fix It" program, where when a mechanic went into a building to do a job

> and found that there was more to do, he wasn't supposed to go back and say there was something else wrong. They were supposed to do everything that needed to be done in that building while they were there.[300]

The structural maintenance and repair team (SMART) was one concept advanced to restructure shops and to improve work efficiency. The shops traditionally were organized by trade. Job orders frequently were subdivided into tasks by trade and assigned to multiple shops. The involvement of a series of shops in a single job order duplicated mobilization costs and extended work schedules. Under SMART, multi-trade teams were assembled to enable holistic project execution. Such teams incorporated all crafts required to complete full job order. The SMART approach was particularly effective in emergency maintenance and repair projects.[301]

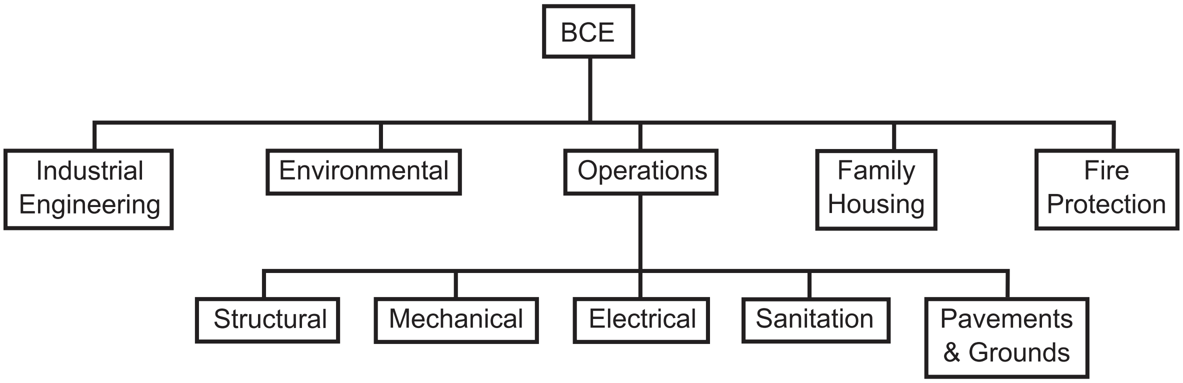
On-base "U-Fix-It" or self-help programs were another strategy to relieve the workloads of the BCE shops and drew upon the initiative of Air Force personnel. These programs fostered maintenance skills among personnel occupying family housing, as well as those working in an office or other facility. These programs encouraged occupants to perform simple maintenance and repairs, and freed civil engineering craftsmen to perform the more difficult projects.[302] Base level self-help programs became particularly valuable during civil engineering deployments and when maintenance budgets were underfunded; the majority of bases operated self-help programs. Self-help centers were an enhancement to self-help programs and staffed by technical advisors in building maintenance and repair. Self-help centers provided technical support for customers taking on work that was a low priority for the BCE shops, and tapped into a volunteer labor force.[303]

Self-Help Program

The idea of a self-help program was suggested by MSgt. Norris Cherry, who was serving with the 52d Civil Engineering Squadron at Spangdahlem AB, West Germany. Sergeant Cherry thought that the program would "encourage people residing in housing to take care of minor but time consuming tasks in their quarters, such as replacing hinges, door knobs, floor tiles or toilet seats." Sergeant Cherry was rewarded $750 for his suggestion, which, in the first three months, eliminated 419 job orders for civil engineers. The Air Force projected that the program would save as much as $17,909 within one year.[304]

Ideas for reconfiguring operations in the base-level shops again were circulating in the mid-1980s. General Ellis was a strong advocate for readiness and the concept that civil engineers should be organized to easily transition from peacetime to war (Figure 4.4). Following one of General Ellis' conferences, Col. Ray Schwartz, Deputy Chief of Staff, Engineering and Services at Strategic Air Command, and his deputy, Col. Allen J. Sailer, agreed that the wartime organization did not rely on a central work control system but rather a direct relationship with the customers and real-time decision making on work priorities and execution. They believed that zonal maintenance could do this and provide more opportunity for young officers and NCOs to gain leadership experience needed during deployments, instill a sense of ownership and pride, and foster some informal friendly competition between zones. They chartered a team to further develop this concept that became known as Readiness and Ownership Oriented Management (ROOM) when it was initiated in 1986. ROOM was a reorganization of the Operations branch to meet readiness requirements while providing the most efficient organization for peacetime operations. It aligned manpower to correlate with wartime requirements and allowed increased war skills training. The concept was developed and tested at Pease AFB, New Hampshire; Loring AFB, Maine; and, Minot AFB, North Dakota in 1986-87. The centralized shops and centralized service call desk were abolished and the people were formed into zonal maintenance groups called "Craft Teams" Under ROOM, work crews comprising multiple skill sets were assigned

Figure 4.4 Standard Base Civil Engineer Organization, 1988



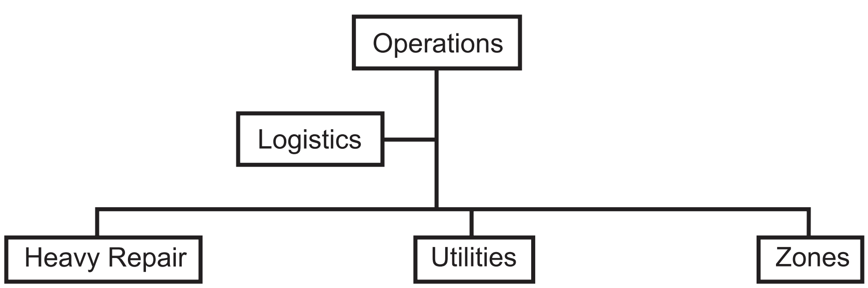
Source: School of Civil Engineering and Services, "Zonal Maintenance," ca. 1992, 4.

to a designated base zone. "The workmen, instead of coming to the civil engineering compound and going off to their job site, just to get back in their car half an hour later, they would report to the trailer to get what they need and go directly to work."[305] ROOM was also designed to avoid the reorganization during contingencies, when civil engineers traditionally formed interdisciplinary teams instead of teams based on crafts. SAC implemented ROOM command-wide in 1987.[306] In an effort to promote ownership and accountability for maintaining Air Force facilities, Colonel Schwartz challenged the engineers at Loring that he wanted a mechanical room where he could eat off the floor. During his next trip to the base, they took him to a mechanical room clean enough that he could have eaten off the floor.[307]

A related concept for reorganizing base shops, Combat Oriented Results Engineering (CORE), was implemented at TAC in 1987 at Luke AFB, in Nevada under the direction of the base civil engineer Lt. Col. Paul Hains. At Luke AFB, maintenance work was subdivided into heavy and light repair and further categorized into horizontal and vertical work. CORE was implemented at Moody, MacDill, and Homestead AFBs in the following year, while the civil engineer organization at Cannon AFB, New Mexico, developed a similar system, known as Combat Engineering.[308] TAC implemented CORE command-wide in March 1990.[309] Both ROOM and CORE located teams of multi-skilled civil engineering personnel in proximity of their assignments and defined area of specialized responsibility.[310]

During 1990, Headquarters AFESC reviewed ROOM and CORE to evaluate their effectiveness on BCE organization and productivity. The best elements of both programs were combined as a result of this in-depth review (Figure 4.5). Under the comprehensive concept of "zonal maintenance," the Operations and Maintenance Branch for each base civil engineering organization was organized into three major components: (a) the zones, (b) heavy repair, and (c) utilities. A typical base was divided into one to six zones. Personnel from the BCE shops were organized into SMART teams responsible for performing repetitive minor maintenance and repair projects on selected base facilities on a regular

Figure 4.5 Zonal Maintenance Organization



Source: "Zonal Maintenance Guide," prepared by HQ AFESC, 1990, n.p.

schedule. The SMART teams comprised approximately 25 craftsmen representing all trades. Intensive repair functions and utilities operation and maintenance were assigned to separate specialized teams. Under zonal maintenance, a customer submitted a work order to the zonal manager responsible for scheduling his team. Jobs exceeding the scope of work performed by the zonal maintenance crew were referred to a work order review panel, which assigned job orders to the heavy repair crew or forwarded them on to SABER for contracting. The advantages of the zonal maintenance approach were direct responsiveness to the customer and enhanced military readiness achieved through the development of leadership, team members, and interdisciplinary skills among the crafts.[311] The anticipated manpower savings led to the adoption of the zonal maintenance Air Force wide in 1992 and paved the way to the Objective Squadron.[312]

Energy and Environmental Planning

Apprehension over access to foreign oil and the adequacy of domestic energy reserves led to action by the U.S. executive and legislative branches that directly influenced Air Force energy policies during the period. Civil Engineering met these national concerns with proactive responses incorporating planning, data collection, and action to adopt less vulnerable energy sources, to implement energy conservation, and to achieve efficiency in energy use.

Energy—its sources, use, and conservation—was an important issue throughout the period 1975-1990. In 1978, the Headquarters AFLC undertook an energy audit in response to Executive Order (EO) 12003, issued on July 20, 1977. The EO required Federal agencies to develop a 10-year energy conservation plan. The ensuing Air Force audit resulted in the Building Energy Audit Program that concentrated on quantifying current energy use and identifying practices for reduced energy consumption in compliance with the EO.[313]

The USAF Energy Plan of 1978 was considered the first step towards assuring the future adequacy of energy supplies. The Energy Group, established at AFESC in 1978 headed by Maj. Birney Pease, and later Lt. Col. William Gaddie and included Capt. Michael Aimone and long-time civilian employees Fred Beason, Larry Strother, and Ed Wilson.[314] The Group managed the Air Force Facility Energy Program and developed policies to ensure compliance.[315] In accordance with EO 12003, the Air Force energy conservation plan mandated a 20 percent reduction in energy consumption by FY85, a 30 percent reduction of FY75 energy levels by FY90, and a 45 percent per square foot reduction in energy consumption for new construction.[316] The plan also required a complete evaluation of all energy programs in the Air Force by the end of FY79 and a path forward to achieving the energy goals set forth by the President, the Department of Energy, and DoD. The Senate Armed Services Committee attached an additional $100 million to the FY78 MCP Energy Investment Program. Included in the Senate Report were recommendations for DoD to "eliminate its reliance on natural gas as fuel for large energy plants (except in rare special situations) by 1980" and "eliminate its requirements for oil as a fuel for large energy plants (except in rare special situations) by 1985."[317] The ten-year facility energy plan provided compliance with EO 11912 (April 13, 1976), EO 12003, Energy Policy and Conservation Act, and DoD Directive 4170.10 entitled Energy Conservation (March 29, 1979). Energy objectives outlined in the plan emphasized energy self-sufficiency at remote sites; established a preference for energy derived from coal, solid wastes, and biomass; and reduced energy usage at facilities.[318] In addition to the Energy Group, AFESC also fielded a Facility Energy Assistance Team. The team evaluated energy consumption and assisted CONUS BCEs in identifying ways to manage and conserve energy in addition to meeting the energy goals for individual bases.[319]

Concentrated effort was expended to convert base utilities from oil to coal. Six coal conversion projects were completed between FY76 and FY83 through an expenditure of $176.6 million in military construction funds.[320] Alternative energy sources were considered by the USAF in the ten-year facility energy plan. The FY81 budget included funding for a nuclear energy plant at Plattsburgh AFB, New York.[321]

In 1978, 77 percent of all energy used by the Air Force was derived from petroleum.[322] Facilities accounted for 29 percent total energy use by Air Force in 1979. The Air Force reduced energy consumption by 1.8 percent between 1975 and 1978. By FY84, energy consumption was down 10.9 percent in comparison to the FY75 levels and the 20 percent reduction requirement for FY85 was met. [323]

Energy continued at the forefront of DoD and Air Force concerns into the 1980s and 1990s. In June 1978, the *Defense Energy Program Policy Memorandum 78-4* created the DoD Energy Awareness Program. The program publicized energy conservation and awareness through energy conservation awards and program recognition throughout DoD.[324] *The Federal Energy Management Improvement Act of 1988* raised energy reduction targets for facilities to 10 percent per square foot. [325] The Air Force closely monitored energy usage through Air Force-wide energy plans, as requested in Presidential and DoD mandates. The reduction rates established for Federal agencies were integrated into Air Force energy objectives. To meet these energy reduction goals, the USAF utilized funds from the Energy Conservation Investment Program (ECIP) to finance energy retrofits. The BCEs were also pressured for energy efficient operational and maintenance work habits. In 1981, Maj. Gen. William D. Gilbert wrote on energy saving procedures for base level operations including "boiler tune-up programs, heating and cooling control calibration, [and] hot-water temperature setbacks."[326] New facilities were constructed to replace energy inefficient buildings; the Army Corps of Engineers and Naval Facilities Engineering Command were the design agents for these projects. [327]

Land use planning and the environment loomed large in the national consciousness during the period as the United States sought responses to the unforeseen effects of past practices and safeguards for the future. As environmental activism increased in the 1970s, the Air Force responded with organizational, programmatic, and policy changes. Threats to the integrity of air base operations from off-base development were recognized. The responsibilities of the BCEs increased to keep pace with a staggering number of environmental laws, regulations, and initiatives. Abatement and disposal programs were executed based on the latest scientific research and best practices of the period.

Legislation promoted collaboration between Air Force installations and local civilian communities on common planning issues. Data coordination and cooperation between Air Force bases and local communities was encouraged through briefings to local communities on mission changes and beddown requirements and through community input in environmental impact statements prepared under NEPA. Greater coordination was sought on flight schedules. By 1975, the Air Force had executed memoranda of understanding with 61 communities.[328]

The Air Installation Compatible Use Zone (AICUZ) was one program under which Air Force BCEs worked with local communities on local planning and zoning issues. The AICUZ program examined off-base land use in the vicinity of Air Force bases and identified suitable land uses in those areas based on specific criteria, such as aircraft noise levels and distances required for runway approaches. The AICUZ reports presented the results of the Air Force analyses of land use plans for adjoining communities and data on aircraft noise levels, accident potential, and airfield and air space criteria; recommendations for local land uses compatible with base operations were identified. Implementation of AICUZ promoted the adoption of land uses by communities surrounding Air Force bases that benefited both the Air Force and local citizenry.[329] AICUZ data also was used to support the acquisition of land near bases with nearby development. Utilizing FY76 MCP, Congress authorized acquisitions at 23 bases and provided the program with $16.4 million. Concurrently, the Air Force initiated additional acquisitions at 10 other bases as part of the Minor Land Acquisition program. Community planning programs utilized AICUZ data during the 1980s in a Joint Land Use Study.[330] By 1977, 42 AICUZ studies were released to the public. The studies all contained recommendations to achieve compatible land use near individual Air Force bases.[331]

In 1979, AFESC managed the natural resources program and was the responsible party for "monitoring, reviewing, and approving/disapproving all installation natural resources plans and cooperative agreements; monitoring and compiling natural resources conservation reports; and acting as point of contact for major commands/AFRCEs on land management, landscape development, forestry, grazing, agriculture, flood plains and wetlands, threatened and endangered species, reduction, and investigation engineering."[332] Each BCE was charged with executing base level natural resources program in compliance with DOD, Public Laws, and Air Force directives, such as AFM 126-1, Conservation and Management of Natural Resources.

The emphasis on resource conservation extended to the identification and management of cultural resources. Compliance with Sections 110 and 106 of the National Historic Preservation Act of 1966 and Executive Order 11593 (1971) were a continuing responsibility for BCEs. On-going efforts to locate, inventory and nominate all eligible properties to the National Register of Historic Places, as well as efforts to comply with regulations (36 CFR 800) to consider the effects of all undertakings upon historic properties and to afford the Advisory Council on Historic Preservation with an opportunity to comment, presented unique challenges to civil engineering. Historic properties, defined as buildings, structures, objects, sites, and districts that possessed significance and integrity under the National Register Criteria for Evaluation (36 CFR 60.4 [a-d]) traditionally were limited to archeological resources and historic buildings on Air Force land that predated military acquisition. The aging inventory of Air Force real property was, however, fast approaching the general National Register 50-year age threshold, necessitating greater consideration.[333]

Pollution abatement was another pressing environmental issue for the Air Force. An estimated $300 million was allocated for pollution abatement between 1967 and 1979; $160 million was allocated for projects through 1984. In 1980, the USAF was in non-compliance with the National Clean Air Act at 22 installations and in non-compliance with the Clean Water Act at 23 installations. In addition, 133 installations had to obtain 175 permits through the National Pollutant Discharge Elimination System, established by the EPA and authorized under the Clean Water Act, that regulated sources that ejected pollutants directly into waterways through permits.[334]

Installation Restoration Programs (IRPs) were implemented at Air Force installations across the country. This program was funded by the Defense Environmental Restoration Account which grew considerably during the late 1980s. By 1989, the AF share of this account was $175 million. The program identified Air Force locations that were used for storage or disposal of toxic and hazardous substances. IRP plans were then developed to remove the threats to the public health and environment. The Office of The Civil Engineer established an outreach program between HQ Air Force and the 10 EPA Regions with annual meetings with the Regional Administrator or Deputy Administrator. This helped defuse issues between EPA regulators and the Air Force before they became contentious and assisted in the Agent Orange project described below. At base level, the BCE was responsible for the first and last phases of the IRP. During Phase I, the BCE identified the potential for contamination sites by reviewing past files and information. Phase II of the process typically was performed by Medical Services, which completed environmental and ecological surveys to confirm contamination. Phase III of the program required reviews of methods of cleanup and restoration and development of a plan for the installation. Phase IV was the implementation of the plan with monitoring completed by the BCE.[335] McChord AFB in Washington state was among the early major Air Force bases to implement the IRP program. Sixty-five sites were identified for environmental cleanup at McChord AFB in 1982; nine sites also were listed on the National Priority List, which identified Federal hazardous waste sites harmful to humans, and 29 sites were identified on the State of Washington's Model Toxic Control Act, state legislation that required identification and cleanup of hazardous sites. By 1996, McChord AFB was the first Air Force installation to achieve 100 percent remedial cleanup.[336]

During the late 1980s, the USAF created the Environmental Compliance Assessment and Management Program to assist installation commanders in complying with all applicable pollution standards and to review the status of their environmental management system and to act as an "annual audit program."[337] The first Air Force Compliance budget line item account was established in 1990 to account and track the tremendous growth of Air Force Environmental expenditures. Funding was available through the Defense Environmental Restoration Account and a contractor was hired to create assessment modules to evaluate environmental and cultural resource issues ranging from air, water, and sewage to asbestos and lead. The Air Staff provided each command with two free audits using the assessment modules to start the program; thereafter, each major command was required to program the funding into its budget.[338]

The Air Force gave the environmental program high-level visibility in the late 1980s. The Air Force Environmental Protection Committee (EPC) was established in 1988. General Ellis proposed that the representatives to the Air Force EPC had to be general officer-level and that colonels could not substitute for their bosses. Many of the EPC's decisions were introduced into the operations community down to the wing level at the bases. At the same time, USAF reassigned the responsibility for environmental compliance from base civil engineers to base commanders. This shift focused greater attention on environmental programs at the base level.[339] Further reorganization of the environmental program in 1986 when, under General Wright, AFESC's Natural Resources Division was eliminated and its functions, including restoration, forestry, the BASH team, the environmental side of pesticides, and general environmental policy, transferred from AFESC to Air Staff. General Wright directed that a manpower study be conducted for the entire Air Force Environmental program resulting in a 30 percent increase in environmental positions worldwide. [340]

Disposal of excess Herbicide Orange was a major environmental project undertaken by civil engineers during the 1970s and 1980s. The U.S. military had developed several herbicides for use as a defoliant to combat the dense jungle foliage during the Vietnam conflict. Herbicide Orange was created in 1962 and became the most widely used herbicide.[341] Agent Orange, as the herbicide was commonly known, was a 50:50 mixture of 2, 4, 5-T (trichlorophenoxyacetic acid) and 2, 4-D (dichlorophenoxyacetic acid). The toxic by-product of 2, 4, 5-T was TCDD (tetrachlorodibenzo-para-dioxin).[342]

The first links of birth defects to Agent Orange were reported in the Vietnamese newspapers during summer 1969. That same year the National Cancer Institute released a study that reported birth defects in laboratory animals exposed to 2, 4, 5-T.[343] The use of herbicides was phased-out due to concern generated by these reports, and, by early 1971, USAF had ceased Operation Ranch Hand, the project for the "aerial spray of herbicides in South Vietnam."[344]

The Air Force had a stockpile of approximately 2.22 million gallons of unused Agent Orange; 1.37 million gallons were located in South Vietnam and the balance was stored at Naval Construction Battalion Center in Gulfport, Mississippi awaiting shipment to Vietnam.[345] Project Pacer Ivy was initiated in 1971 with the purpose of "redrumming" and moving surplus herbicide from South Vietnam to Johnston Island.[346] The Agent Orange stored at Johnston Island and the Naval Construction Battalion Center, raised the question of disposal of the excess herbicide. Several options were considered, ranging from: "soil biodegradation, high-temperature incineration, deep-well injection, burial in underground nuclear test cavities, sludge burial, and microbial production."[347] Many options met with strong opposition; high-temperature incineration at sea was selected as it was the only viable disposal method at that time.

To burn Agent Orange at sea, the USAF needed an ocean-dumping permit issued through the Environmental Protection Agency (EPA). The EPA enforced strict regulations upon the incineration, including a set emission rate of one-tenth of one percent of the total amount incinerated, a specific locale for incineration, the required use of monitoring devices, and the obligatory rinse of the drums with the rinse being incinerated.[348] Agent Orange was incinerated between July to September 1977 aboard the Dutch ship, *Vulcanus,* as part of Project Pacer HO. Nearly 15,500 drums of Agent Orange were incinerated from Naval Construction Battalion Center Gulfport, Mississippi, and approximately 24,800 drums from Johnston Island.[349] This EPA approval was obtained when Col. Donald Kane, Air

Force Environmental Division Chief, met with the EPA Region IV Administrator on this tough stalled issue. The Administrator suggested that the Air Force use a Resource Conservation and Recovery Act Research and Development permit in place of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 cleanup process. The permit was fast tracked through Region IV and when the effort was completed, there was no contaminated soil to remediate. The agency relationships established between the Air Force and EPA had smoothed this whole process.[350]

As a condition of the EPA permit, the USAF was required to monitor the former storage and test sites. Following the incineration, the USAF Occupational and Environmental Health Laboratory began analysis of facilities at Johnston Island; at Gulfport, Mississippi; and, at Eglin AFB. Residual effects of Herbicide Orange were examined in "soil, silt, water, and biological organisms."[351] In a 1981 memorandum, Col. Walter J. Rabe, Director of Avionics and Weapons, forwarded a proposed Statement of Need (SON) for validation. The purpose of *USAF SON 2-81, Reclamation of Herbicide Orange Contaminated Sites* was to document the levels of contaminants at the storage and tests sites and to confine the toxic residue. The SON emphasized the necessity for developing methods for decontamination so that the sites could be returned to full use. The ESL was appointed the "lead laboratory for monitoring and reclamation research."[352] The Environics Division of the ESL collected samples at Eglin AFB, Johnston Island, and the Naval Construction Battalion Center at Gulfport, Mississippi, throughout the 1980s. In 1988, the EPA approved an incinerator project to destroy the residual contaminants at Gulfport, Mississippi. The incinerator was capable of disposing more than 100 tons of contaminated soil daily; the project processed 26,000 tons of soil from November 1987 through January of 1989.[353]

CONSTRUCTION

Introduction

The Department of the Air Force continued to rely upon the Army Corps of Engineers and the Naval Facilities Engineering Command as construction contract agents throughout this period. Civil Engineering programmed and managed an ambitious volume of base level improvements and new construction as well as specialized construction for domestic and international customers. Increased livability and quality of life was emphasized in domestic construction programs. Projects for facilities to support defensive weapons and sophisticated surveillance were completed in the CONUS while overseas projects supported the national posture of détente with the U.S.S.R.

CONUS Construction

Air Force civil engineers constructed a handful of new construction projects through the Military Construction Program (MCP), later known as MILCON, while the Army Corps of Engineers and the Naval Facilities Engineering Command served as contract agents for approximately 90 percent of Air Force construction. The Air Force Civil Engineering role in all construction funded through MCP extended to the identification of construction requirements, preparation of technical and functional criteria, preparation of the funding programming, justification of the construction program to the U.S. Congress, project siting, and oversight of the design and construction processes.[354]

The Air Force Regional Civil Engineers (AFRCEs) under the direction of USAF Headquarters at the Pentagon coordinated the Air Force construction program with the contracting agents in the Army and Navy. AFRCE offices, located in Atlanta, Georgia; Dallas, Texas; and, San Francisco, California, were responsible for managing the design, contract award, and construction phases of all projects funded through the MCP. By 1979, the AFRCEs'role expanded to encompass MCP management for all Air Force bases and the Reserve Forces, including the Air Force Reserves and the Air National

Guard; commissary design and construction management of projects exceeding 300,000 dollars; family housing repair, improvement and construction program management; management of acquisition and disposal of real property, primarily land acquisitions; and, management of Air Force environmental planning and compliance activities on the Federal and state levels. Each AFRCE office worked with the bases and organizations within its geographical region; offices worked directly with as many as 12 major commands and 81 Air Force installations in their respective regions. The AFRCE staff comprised professional military and civilian engineers, architects, and community planners.[355]

The remaining 10 percent of Air Force construction was exclusively controlled by Air Force civil engineers through programs at the Pentagon level, at major commands, and at overseas commands. Housing was one area where Air Force civil engineers controlled the entire construction program through in-house civil engineering expertise and contracts with architecture and engineering firms.

The Military Family Housing Program for FY76 reflected an emphasis on environmental awareness and energy conservation. The $16 million budget included such energy saving measures as "additional insulation, storm windows or double-pane windows, weather stripping and caulking…" and "flow control shower heads, fluorescent light fixtures."[356]

During the mid-1970s, the USAF reviewed base livability as a standard for housing and base planning. In 1976, the Civil Engineering and Services Directorate investigated "certain aspects of the livability question as they pertain to residential, commercial and community services situations."[357] Livability was seen as supporting morale and, consequentially, improved mission effectiveness. New programs were implemented to improve base and family housing. The Military Family Housing Post Acquisition Improvement Program combined two separate programs, Family Housing Improvement and Family Housing Repairs. The integrated program allotted $15,000 per unit for renovations.[358] New housing featured "an innovation known as the 'family room' which satisfies the need for more separation of activities and greater privacy."[359] Amenities, such as dishwashers, clothes washers, garbage disposals and additional bathrooms, were added to existing housing units as livability upgrades.

Temporary Lodging Facilities (TLFs) garnered attention from the USAF during the 1980s. TLFs were on-base quarters used primarily to help relieve the financial impact and family separations during a permanent change of station move. They provided housing for families while awaiting delivery of furniture, while making arrangements for permanent housing, or for families visiting Air Force hospitals. Although there were 2,566 units at 89 bases by 1983, a critical shortage remained with nearly 20 bases having no TLFs. In the early 1980s, it became increasingly difficult to fund TLFs through the MCP and alternate methods of financing were explored. Beginning with FY83, the Air Force Welfare Board, which directly managed several non-appropriated funds, agreed to loan $53 million for TLF construction during the FY83-85 time period.[360]

Under the directorship of Maj. Gen. William D. Gilbert, housing improvement was a major priority. The FY78-81 MILCON budgets included $180 million in improvements to enlisted personnel dormitories and 1,560 family housing units were constructed overseas.[361] The FY84 housing program was aimed at decreasing the unaccompanied personnel housing (UPH) deficit. The $260 million program sought to create 15,600 spaces. A waiver was granted in 1984 to allow two Airmen to occupy three-person rooms in USAFE. Later that year the waiver was extended to include all Air Force bases. The Air Force increased their UPH by 52 projects to accommodate 13,693 enlisted and 590 officers in FY86.[362]

CONUS Construction – Special Projects

USAF civil engineers also contributed their expertise to a variety of special projects. Some were related to the evolution of the space and missile programs. These projects offered civil engineers an opportunity to be involved in high-profile projects that used the latest technology to support military missions.

Missile-X Construction Support

The development of the “Missile-X” (MX) began in 1972 and continued through the late 1970s and the 1980s. The complexities of developing the actual missile were compounded by the additional challenge to create a basing system that could be concealed to avoid Soviet attack. The silo based system was questioned by Congress as the military struggled to develop the ideal technique for launching. Congress made its lack of support for a silo-based MX known in July 1976, when it declined to provide funding. Members of Congress considered a trench or shelter launched missile to be a more rational approach. By 1979, the Air Force had assessed 40 alternative basing systems for the MX. Alternatives included rail-based, plane-based, and ground-based launch facilities. In June 1979, President Carter agreed to allow complete development of the MX. It was considered the largest construction project ever faced by the Air Force. Four months later, President Carter approved a “horizontal multiple protective shelter” system for the missile, and the development began.[363]

On March 14, 1980, the Air Force Regional Civil Engineer MX (AFRCE-MX) was established at Norton AFB, California to oversee the early phases and was assigned the task of managing real property associated with the MX program. The office was created with the assumption that it would be flexible in accommodating program changes and staff levels. AFRCE-MX at Norton AFB was proposed to employ 77 personnel by the close of 1980 and 184 personnel by 1983. The personnel level was expected to decline to 138 by 1986. Operating sites, which were created as liaisons to the Air Force Engineering and Services Center and Headquarters U.S. Air Force, were planned for Tyndall AFB in Florida and Bolling AFB in Washington, DC. Col. Danny N. Burgess headed up the AFRCE when it was first established and was succeeded by Brig. Gen. Charles W. Lamb, who served as AFRCE-MX chief from 1981 to 1983. The AFRCE was collocated with a Corps of Engineers organization, headed by a brigadier general, which facilitated close planning and execution of individual projects that supported the fielding of ballistic missiles.[364]

A milestone was reached with the creation of the AFRCE-MX organization and the corresponding involvement of Air Force civil engineers. As the MX program grew and transformed over time, so did the responsibilities of the Air Force civil engineers. Working in an area of advanced engineering and construction, the Air Force civil engineer also was placed in the limelight of the largest and most cutting edge defense program undertaken by the Air Force. Air Force civil engineers worked with counterparts throughout DoD and throughout the world. Lt. Col. Thomas L. Bozarth, then program manager in the Programs Division, Directorate of Engineering and Services, pointed out the significance and breadth of the AFRCE’s involvement in the MX program in a 1980 article on the topic:

> Conceptual planning for new installations, establishing an AFRCE MX, preparing environmental impact statements, working on renewable energy sources, and programming test facilities are examples of how Air Force Civil Engineers are helping to bring the nation’s most advanced land based weapons system into operation. It is evident that those involved in facilities programming, environmental planning, criteria development, and design and construction management will continue to play a key role in the success of the M-X weapon system.[365]

The process to complete an environmental impact statement for the program was unprecedented. The potential scope of the preferred deployment in Nevada and Utah was to build two complete Air Force bases, one in Coyote Spring Valley north of Las Vegas, Nevada, and the other near Milford, Utah. This “Proposed Action” was to disperse the support bases and missile launch facilities over approximately 8,500 square miles, but with only about 43 square miles of land to be fenced—mostly the supporting bases. Approximately 8,500 miles of roads were planned, of which 1,400 miles would be paved with 80,000 acres of land needed for rights-of-way. All roads would be opened to public use. Approximately 160,000 acres of land would have been disturbed during construction. As required by the Council on Environmental Quality environmental impact statement guidelines, all feasible alternatives, including a "No Action" alternative, had to be analyzed and compared with the "Proposed Action." A total of eight viable deployment alternatives were found for deploying 200 missiles throughout the region.[366]

The environmental impact statement process, managed by AFRCE-MX, cost tens of millions of dollars. Among other expenses in the process, remote aerial sensing of natural flora and fauna habitat had to be mapped and species identified and populated for impact analysis. In addition, human environmental resources such as land ownership; housing; employment before, during, and after deployment; Native American cultural resources; land and water use; as well as archaeological and paleontological resources had to be quantified and assessed for impact and mitigation planning. Operational suitability sites had to be analyzed and chosen for potential environmental impact mitigation. More than 40 public hearings were conducted by AFRCE-MX officials in the deployment areas to present the project and record public commentary on the planned actions. When the final statement was filed in January 1984, the analysis process was considered to be the largest and most comprehensive ever undertaken by any government department or agency.[367]

In 1981, President Reagan suspended work on the horizontal shelter basing system and approved MX missiles launching from Titan II and Minuteman silos; he also renamed the missile the Peacekeeper. In 1983, the Department of Defense approved the placement of 100 Peacekeeper missiles within adapted Minuteman silos located at F.E. Warren AFB in Wyoming. The project was assigned to the Air Force. After several experiments and design changes, the Peacekeeper was tested in June 1983 at Vandenberg AFB, California and went into production in February 1984.[368]

The Reagan Administration's decision to abandon the horizontal shelter basing system and to support the use of Minuteman silos prompted an evaluation of the AFRCE-MX. The purpose of the assessment was to determine the ability of the AFRCE-MX to handle the planning required for the newly authorized missile program. AFRCE-MX reported to the Ballistic Missile Office (BMO), which served as the general manager of the program under Headquarters U.S. Air Force, Directorate of Engineering and Services. A July-December 1981 document produced by the Office of the Special Assistant defined the responsibilities of the AFRCE-MX as the Facility Program Manager:

- Collection and consolidation of facilities requirements and criteria
- Environmental planning
- Programming
- Design and construction
- Integrated program scheduling
- Interim Operations, maintenance and services
- Support of M-X facilities R&D programs[369]

In addition to Headquarters U.S. Air Force, these responsibilities were administered in coordination with individual bases, major commands, and other counterparts. The tasks assigned to the AFRCE-MX were not always straightforward; the organization maintained flexibility and mastered the ability to adapt to program changes. The MX program was envisioned to span years and to require an enormous design and construction effort.[370] As part of the MX program, AFRCE-MX also coordinated with non-DoD agencies, including:

- Environmental Protection Agency in preparing Environmental Impact Statements;
- Department of Interior on land withdrawal procedures;
- Department of Education on schools impact;

- Department of Health and Welfare on other community issues; and
- Department of Energy on renewable energy[371]

In 1982, AFRCE-MX, Headquarters SAC, and BMO were given authority by Headquarters U.S. Air Force to begin organizing and overseeing visits by the USAF and contractors to potential basing sites. Six bases were chosen: Malmstrom AFB in Montana, Ellsworth AFB in South Dakota, Minot AFB and Grand Forks AFB in North Dakota, Whiteman AFB in Missouri, and F. E. Warren AFB in Wyoming. Headquarters U.S. Air Force stipulated that "all six Minuteman bases must be given equal considerations and treatment prior to selection of the preferred deployment site."[372]

Once again, Congress raised red flags and, in 1985, reduced the installation of Peacekeeper missiles within silos from the 100 previously approved by DoD to 50. Congress pushed the Reagan Administration to propose a more viable basing system for the missile. The task of placing the 70-foot tall 195,000 pound Peacekeeper missile within a Minuteman silo designed to hold less than half that amount of weight was a daunting one. Eventually, the silos were refitted to accommodate the Peacekeeper. [373]

Speakers at the 1985 Air Force Association National Symposium revealed frustrations over the constant modifications to the MX Peacekeeper program. Gen. Lawrence A. Skantze, who served as commander of Air Force Systems Command, claimed "we will never produce Peacekeeper missiles at an economic rate because of the political perturbations." Continual alterations to the program cost money and also cast doubt on the defense capabilities of the United States. General Skantze continued, "after three false starts with earlier basing modes that cost the taxpayer $3.5 billion, Congress last year voted to deploy 100 Peacekeepers in Minuteman silos. Now, some elected officials don't like the basing mode for Peacekeeper and are restricting the number we can…produce and deploy…it sends confusing signals about our national will [and] detracts from our ability to provide an essential military capability." Gen. Bennie L. Davis, who served as Commander in Chief, Strategic Air Command, characterized the MX program as a "political football," stating that "fifty is better than none, but it's not enough to meet the very real military requirement."[374]

In 1986 President Reagan approved the Peacekeeper Rail Garrison system, which placed paired missiles on 25 train cars located at USAF bases. Rail cars would be hidden within barricaded garrisons, and when activated they could access 150,000 miles of railroad tracks. Individual trains would be accompanied by security cars, launch cars, control cars, and maintenance cars. While the rail garrison system was under development, the installation of Peacekeeper missiles within silos moved forward in Wyoming. The first operationally alert Peacekeeper missile was put in place in October 1986 at F.E. Warren AFB. Two months later an additional ten were placed on alert status. The total 50 were operationally alert in silos at F. E. Warren AFB by December 1988. The missiles were in service for 19 years, until their deactivation in 2005.[375]

The U.S. also developed a small ICBM, known as the "Midgetman," in the mid-1980s because of the basing controversies related to the Peacekeeper. The Midgetman was to be based on special hardened mobile launchers which could disperse when necessary. The AFRCE-Ballistic Missile Support (BMS, formerly the AFRCE-MX) worked basing and siting issues involved with the system and prepared a Siting Program Management Plan. The AFRCE also developed a Legislative Environmental Impact Statement procedure that eased the process by tiering the issues and was adopted in the 1986 DOD Authorization Act. The AFRCE-BMS released the environmental impact statement for the first beddown location at Malmstrom AFB, Montana in early 1988. The Midgetman's first successful full-scale test launch was conducted in 1991, but with the end of the Cold War, the program was terminated in 1992.[376]

In 1987, Congress allotted $350 million for additional research and development of the rail garrison system. In November 1989, seven installations were chosen for placement of the systems: F.E. Warren AFB, Wyoming; Barksdale AFB, Louisiana; Little Rock AFB, Arkansas; Grand Forks AFB, North Dakota; Dyess AFB, Texas; Wurtsmith AFB, Michigan; and Fairchild AFB, Washington.[377] The rail garrison system was never fully developed as a result of diminished Soviet threats. During an address to the nation on September 27, 1991, President George H. W. Bush stated, “the prospect of a Soviet invasion into Western Europe, launched with little or no warning, is no longer a realistic threat…I am terminating the development of the mobile Peacekeeper ICBM.” Deactivation of the Peacekeeper ICBM did not begin until October 2002.[378]

Vandenberg Space Launch Complex

From the early 1970s, the Department of Defense and the Air Force had been seeking a location to launch the Space Shuttle into a polar orbit. Data relayed from a polar orbit was critical to specific types of military communications, weather, and surveillance satellites, since the orbit provided almost unlimited coverage of the planet’s surface. Launches from the Kennedy Space Center, which supported the civilian space program, were limited to equatorial orbits to avoid overflying densely populated areas. Reorienting to a polar orbit after an initial equatorial launch was possible, but required additional fuel, thus reducing the spatial capacity of the vehicle for equipment. The logical choice for a launch site for polar orbit was Vandenberg AFB, California. The Air Force launched its first intermediate range ballistic missile in 1958 from Vandenberg. In addition, over 1,500 successful missile launches and launches of unmanned space vehicles occurred at the base during the 1960s and early 1970s. The base was situated ideally. Located in northern Santa Barbara County, California, Vandenberg is sited at the tip of Point Arguello, a large promontory that juts several miles into the Pacific Ocean. From here, launching a space vehicle to the south and into a polar orbit was possible without risk to the civilian population.[379]

Design of the Space Launch Complex was completed by the Air Force; the Army Corps of Engineers was responsible for construction management.[380] Georg O’Gorman was selected as the Air Force’s overall site manager. O’Gorman arrived at the site in 1978 and construction began the following year. Officially called Space Launch Complex 6, and nicknamed Slick 6, the project was described as the “most sophisticated military complex ever built.”[381] Air Force Colonel Walter Yeager, commander

Space Launch Complex 6 at Vandenberg AFB, California.

of the Shuttle Activation Task Force, explained in a 1984 interview for *Time* magazine: "There have been larger and more expensive projects, but I doubt if there have been any more complicated."[382] With an estimated cost of $570 million for the buildings and structures, and an additional $2 billion for the most advanced computers and electronic equipment, Slick 6 would rank as one of the most expensive Air Force undertakings.

Rather than build from the ground up, the Air Force saved an estimated $200 million in construction costs by reusing elements of the Manned Orbital Laboratory launch facility, a project abandoned in 1969.[383] These elements included the 315-foot mobile service tower (MST), launch control center, and a single flame duct. The MST was shortened by approximately 40 feet, and salvaged steel was re-used in construction of the access tower, the structure that provided access to the Shuttle. Two additional flame ducts were constructed to divert the exhaust from the Shuttle's solid rocket boosters (SRBs). A new technique was developed for pouring the concrete that applied a vacuum to the surface of the concrete while setting. This system rapidly drew out moisture and air resulting in a smooth, glass-like surface that better resisted the heat and flames of the exhaust.[384]

The most imposing buildings of the resulting launch complex were the three "traveling skyscrapers" used to assemble the Shuttle. The first was the 27-story MST. Weighing over 8,000 tons, the tower moved on tracks 450 feet to the launch pad. Using a 200-ton crane in the top of the MST, the segments of the twin SRBs were raised into position. Next, the 250-foot tall, 3,000 ton Shuttle Assembly Building (SAB) moved from the opposite end of the launch area to mate with the MST. With the added lift of the SAB's 150-ton crane, the external tank and, eventually, the Orbiter were to be assembled on the launch pad. The Shuttle Assembly Building was not part of the original plans for the complex. The original system for erecting the Shuttle called for a MST crane and a "strongback" attached to the Access Tower. This method had a tolerance limit of ¼ inch; however, NASA called for a limit roughly one-half that. Vandenberg's chief of public affairs, Maj. Ronald L. Peck, noted "With the wind and weather at Slick Six, we knew we could never get it down to that. So they went back to the drawing boards and came up with the Shuttle Assembly Building. We call it our $40 million one-sixteenth of an inch."[385]

Payloads for space missions were readied in the Payload Preparation Room (PPR). The quality of the atmosphere in the PPR was strictly controlled. First Lt. Nanelle Fulks, payload test engineer responsible for the PPR, was responsible for the building: "We have to make sure the surfaces are extremely clean, and that the air condition filters and heating and ventilation systems remove all particles from the air. The smallest dirt particle could cause one of the subsystems to malfunction and then we'd have this expensive piece of equipment in space, unable to do its job."[386]

Handling the completed payloads at Vandenberg used a different method than that employed at the Kennedy Space Center. Rather than store the equipment in bulky containers where cleanliness might pose an issue, the payloads were transferred to the Payload Changeout Room (PCR); a 158-foot high, 6,000-ton building that moved on rails. The PCR parked next to the PPR and inflatable seals on each section sealed the matching doors. After transferring the equipment, the PCR moved down the tracks and entered the SAB through a six-panel garage-type door. Each section measured 30 feet tall by 130 feet wide. When mated with the Orbiter, the seals were re-inflated and the equipment transferred to the Shuttle. Prior to launch, all the buildings were moved back to their original locations and anchored to the concrete pad.[387]

Air Force engineers monitored all the work: "Our guys supervise each area, handle every problem and every change. They are responsible for everything that goes on inside the buildings." Captain Rusty Keller, the engineer managing the PCR explained, "The test operations folks monitor and control all testing going on inside the building, but I make sure their tests don't impact other work that may be scheduled. We get a daily schedule summarizing activities throughout the day on the complex and inside each facility."[388] First Lt. Kelly Coen, who managed the MST had similar responsibilities, "We meet daily, usually in the morning, to talk about any problems that may come up. We go over the schedule to see what has been planned inside the MST."[389]

Construction of the launch complex was not the only project for the Shuttle at Vandenberg. A similar launch and recover scenario to that used at Kennedy was planned. To safely land the Shuttle, the 8,000-foot runway at the base was lengthened to 15,000 feet and the concrete surfaces were inspected for adequate bearing capacity. Unfortunately, the runway was 17 miles from the launch complex. To solve this logistical problem, a specialized, self-leveling 76-wheel transport vehicle was built. The roadway to Slick 6 was widened and reinforced. Many hills along the route were cut to provide clearance, signs were lowered, and power poles were moved. Security gatehouses were modified so that they could be wheeled out of the way. On January 28, 1985, the Orbiter *Enterprise* was transported from its maintenance facility to Slick 6 for training and fit testing. Under the direction of 1st Lt. Mark Erkilla, the convoy made the trip in six hours traveling between two and five miles an hour.[390]

The first launch at Slick 6 was originally scheduled for October 15, 1985; the date was pushed back to late 1986. By the late 1980s, four launches a year were planned and the design of facility could accommodate up to ten annually. Unfortunately, the tragic loss of the Orbiter and crew of *Challenger* forced the suspension of the Shuttle program and the space complex at Vandenberg was abandoned.[391] Policy decisions during the interim placed sole control for the Shuttle program with NASA. These decisions combined with cooling Cold War tensions eliminated the need for the second Shuttle launch facility and Slick 6 was never used to launch a manned space flight.

Project Touchdown

Another project related to the space program was undertaken for NASA at White Sands Missile Range, New Mexico. During the late 1970s, NASA requested a "comprehensive evaluation" of airfield conditions to support the Space Shuttle Program. The evaluation included "load bearing tests, soil borings, and related soil tests on the two unsurfaced runways, overruns and tow way, and surface profiles on the runways and overruns."[392] The key purpose of the project was to determine the suitability of the "Northrup Strip," at White Sands Missile Range, about 30 miles west of Holloman AFB. This location had been selected as a back-up site for the Kennedy Space Center and the Rogers dry lake bed at Edwards AFB, California. Air Force civil engineers at Northrup Strip were tasked with evaluating the existing surface and subsurface conditions for the Orbiter's landing (weighing approximately 200,000 pounds), its transportation while attached to a Boeing 747-100 aircraft, and its take-off with a combined weight of about 738,000 pounds. After the evaluations were completed, AFESC produced recommendations for remediation on areas found structurally inadequate. The final objective was certification of the Northrup site as adequate for Orbiter landings. [393]

The Northrup Strip was used previously as a bombing range for testing of the Army's LANCE missile. As a result, the area was pitted with both small bomb craters and large depressions. Smaller depressions were filled naturally and larger ones were filled using bulldozers; both left soft surface deposits.[394] An unsurfaced runway measuring 20,000 feet long and 300 feet wide was later extended by NASA to 37,000 feet. NASA also constructed a second runway with the same dimensions as an alternate landing bearing. In both cases, the operational length of the runways was 15,000 feet with 10,000 overruns on each end, comparable to those at Kennedy Space Center and Vandenberg AFB.[395]

The 1979 field test required the following: "control survey; LASER profilometer; soils exploration; test pits; field California Bearing Ratio and soil moisture and density tests; simulation of the Space Shuttle Orbiter gear load with a load cart; and determination of horizontal Orbiter tow force on the unsurfaced gypsum materials."[396] The work was under the direction of the Pavement Division of AFESC assisted by 820th and 823d RED HORSE squadrons, and the 49th CES from Holloman.[397]

Simulated landing tests required the development of a special load cart with landing gear simulating that of the Orbiter. Lead ingots with a total weight of 107,000 pounds were loaded onto the cart, which then was towed on the runway to simulate a landing. Initial testing with the load cart indicated that heat build-up in the tires led to numerous failures; field crews quickly learned to change tires and control temperatures. The cart accumulated about 500 miles of test lines.[398] The field test identified weak areas in the surface and mantle from cratering or sand boils. Sand boils were weak areas caused by hydraulic pressure on the mantle resulting from rising groundwater. Recommendations were developed to repair the surface of the runways and tow ways with a "select gypsum material" and to complete new tests using the load cart prior to certification.[399]

NASA submitted a statement of work in 1980 to AFESC requesting a retest of the repaired surface areas. The load-bearing tests were completed during January 1981 and utilized a load cart provided by NASA.[400] After the completion of three surveys by AFESC, NASA was able to remediate the weak surfaces to withstand the Orbiter's 200,000 pound landing weight and the 738,000 pound transportation weight. Certification was granted for both runways at Northrup Strip after the 1981 tests.[401]

Air-Launched Cruise Missile

The Air-Launched Cruise Missile (ALCM) was an air-to-land target weapon. The missile was designed to launch from a B-52 bomber. Boeing was granted the contract for development of the ALCM in 1974; it was initially coined the AGM-86A. The first test flight of an AGM-86A took place in March 1976; the following year, production of the weapon was approved. Missile technology during this period was constantly advancing. As a result, the approved ALCM was modified prior to production. The primary reason for modifications was to engineer a cruise missile with a greater launch range of approximately 1,500 miles. The result was an Extended Range Vehicle, which was coupled with the ALCM to create the longer range AGM-86B. The AGM-86B was first tested in 1979; missile assembly began shortly afterwards. The ALCM was innovative, to say the least; unlike a ballistic missile, the ALCM was capable of following a course beyond its initial launch. The revolutionary Terrain Contour Matching system allowed for missile control along a predetermined course and 100 foot accuracy. In addition, the ALCM performed at low altitudes, avoiding enemy detection.[402]

In January 1979, SAC's Air Force Regional Civil Engineer (AFRCE) office and USAF civil engineers with the Aeronautical Systems Division (ASD) were assigned the task of designing ALCM support facilities. The following month, the USAF reported their ideas to the Missouri River Division and Omaha District of the Army Corps of Engineers. The Omaha District of the Army Corps of Engineers created a Special Projects Office in March 1979 to coordinate the efforts of SAC AFRCE representatives and ASD civil engineers. By April, it was estimated that the facilities necessary to support an ALCM base would cost $20 million. Initially, two ALCM base plans were simultaneously created because the actual base for the first installation of facilities had not been chosen. Designs were produced for Griffis AFB in New York and Wurtsmith AFB in Michigan. All plans were coordinated through the Omaha District, which was designated as the "central design team."[403]

This early coordination with SAC AFRCE and ASD permitted an efficient method of development. As a result, by the time Griffis AFB was selected as the first base to accommodate an ALCM mission, the primary designs were ready. The ALCM support facilities at Griffiss AFB were finished by September 1981. In December 1982, the 416th Bomb Wing of the Eighth Air Force at Griffiss AFB became the first USAF unit to reach ALCM operational capability. By 1984, ALCM facilities at Wurtsmith AFB in Michigan and Grand Forks in North Dakota were completed. Design and construction of an ALCM facility incorporated many considerations, including unarmed weapons storage, integrated maintenance, storage igloos, mission data processing systems, security coverage, plumbing, fire detection, electricity, and other elements associated with transportation, security, and support. The USAF projected that, by completion, its support of the ALCM program would cost $225 million; in addition, the necessary supplies, testing, and research were estimated at $5 billion.[404]

Construction of the Aeropropulsion Systems Test Facility at Arnold Engineering Development Center

The Air Force Directorate of Civil Engineering was the design agent for the Aeropropulsion Systems Test Facility (ASTF) constructed at the Arnold Engineering Development Center (AEDC) in Tennessee. Designing the facility was a multi-year process that occurred between 1972 and early 1977. The project was fully funded at $437 million. The construction contract was awarded in August 1977 for $261 million. Air Force Systems Command (AFSC) was delegated the responsibilities to manage the design and construction contracting of the project; these responsibilities were then delegated to AEDC. The U.S. Army Corps of Engineers served as the construction agent.[405]

Construction of the ATSF was not without difficulties. By 1981, the cost of constructing the ATSF had risen from $437 million to $575.4 million; a cost overrun of $138.4 million. One potential cause of the problem was that the entire sum of $437 million was appropriated in FY77, rather than through incremental, sequential appropriations planned for by the Air Force during the multi-year construction process. The lump sum appropriation required the Air Force to redesign its contract packages into two concurrent contracts, one for construction and the second for the procurement of government-funded equipment. Incremental funding would have provided regular oversight of the project's budget.

Another problem was the technical complexity of the design of the test facility and the procurement of one-of-a-kind equipment required to make it operational. The original designs did not include sufficient information about installing equipment and instrumentation into the structure; this lack required many change orders that increased the overall cost. Other problems with the project stemmed from inadequacies in the design review process. The Air Force civil engineers did not have sufficient personnel to complete the design review required for this large and technically-complex project; the U.S. Army Corps of Engineers were not funded to complete a design review. Ultimately, the project's problems were determined to be inadequate management that led to the budgetary problems. While some pointed to the U.S. Army Corps of Engineers, the actual problem was with Air Force management of the project.[406]

Maj. Gen. Clifton D. Wright, Jr., Director of Civil Engineering at that time, recalled:

> When I got into the details of what went wrong, I learned that the problems were actually the result of poor planning, equipment procurement procedures, and program management on the part of the Air Force, not the Corps of Engineers, the design and construction agent. There was enough blame to go around, but the root cause was that the Air Force had too many organizations involved without adequate program management oversight and experienced leadership.[407]

General Wright instituted a senior-level oversight group to oversee the project. He chaired the group and Col. Guy York served as Air Force Program Manager. Other representatives were from the U.S. Army Corps of Engineers, the Air Force Systems Command R&D community, procurement officers, equipment manufacturers, the Architect-Engineer, and the construction contractor. Considerable time was spent getting the program on track, and the settlement of a multi-million dollar claim with Al Dorman, then president of DMJM, resulted from the actions of the oversight group. As General Wright noted, similar senior-level review groups were assembled for other major Air Force military construction projects, such as "reserve materiel in the Middle East, the GLCM [Ground-Launched Cruise Missile] in Europe, the Air- Launched Cruise Missile program at several CONUS bases, the Space Shuttle Launch complex in California, B-1 facilities at Dyess AFB, Texas, and the Consolidated Operations Center at Falcon AFB, Colorado."[408] One result of civil engineers' experience with the ASTF was the development of PACES, Parametric Cost Estimated System, which integrated design, design review, and project estimating.[409]

An aerial view (looking west) of the Aeropropulsion System Test Facility (ASTF) under construction at the Arnold Engineering and Development Center, 1983.

The ASTF became fully operational in 1985 and has proved its worth in many testing programs.[410] Testing of the Pratt & Whitney F119 power plant for the F/A 22 *Raptor* and the Pratt & Whitney F135 for the F-35 *Joint Strike Fighter* was conducted at ASTF. In addition, as part of Federal law allowing U.S. Government agencies to support private research, aircraft engines for the Boeing 777, the Airbus A380, and Rolls-Royce engines for both aircraft have been tested at ASTF.[411]

Consolidated Space Operations Center

Space Command began construction of the Consolidated Space Operations Center (CSOC) in May 1983. It was a project with an estimated construction cost of $142 million and a scheduled completion date of October 1985. Located at Falcon Air Force Station (now named Schriever AFB) near Colorado Springs, Colorado, the center encompassed a square mile of property and featured four principal buildings. The initial mission of the center was to "operate satellites, help train military astronauts, and plan space shuttle missions."[412]

In January 1984, Gen. James V. Hartinger, Commander of the USAF Space Command, gave an address at the Engineering and Services Conference on Programming. During his talk, General Hartinger discussed the future CSOC stating that it "will be the centerpiece for military space operations and will be the key element for the Space Command to provide consolidated management of space systems."[413] Air Force civil engineers played a key role in the construction of CSOC. Lt. Col. Joseph J. Loncki, who served as Resident Engineer with the Air Force Regional Civil Engineer-Central Region (AFRCE-CR), was responsible for supervising construction and guaranteeing that it was completed on time and on budget. In essence, the Resident Engineer represented the Air Force element of the construction phase.[414]

The AFRCE-CR Resident Engineer coordinated with the Corps of Engineers, which served as the contractors' representative on the project. Guaranteeing timely construction and financial control was no easy task. The construction was divided into two phases - Phase I addressed basic infrastructure such

An aerial view of the Consolidated Space Operations Center, Falcon AFB, 1987.

as roads and utilities. The $6.1 million contract for Phase I was awarded to Schmidt-Tiago Construction Company. Phase II, a $63.9 million contract awarded to Bechtel National, Inc., included construction of buildings, additional roads, landscaping, and other support facilities. The two-phased approach allowed construction on Phase I to continue, while design of Phase II was underway. This approach provided ample opportunity to discuss the development of the project and to address arising issues throughout the process, which was vital for a project of this magnitude. The AFRCE-CR's duty to oversee both phases of construction and to monitor scheduling and budgets required close project scrutiny as well as constant communication and availability. The scale of the project necessitated teamwork; working together in an organized and communicative environment quickly became a critical requirement. Construction of the CSOC was completed one month ahead of schedule in September 1985. The final cost of construction was below $100 million.[415]

J.B. Cole, who served as the senior Air Force representative for the CSOC construction project, recalled, "the building of CSOC was a fabulous experience…we were able to bring in the project in a way that brought the Air Force a lot of credibility."[416] Their substantial involvement with the CSOC project allowed USAF civil engineers to demonstrate their capacity to undertake significant projects; in particular, a project that involved cutting-edge technology.

Construction in Alaska

Alaska experienced a significant change in its air defense system in the 1970s. As a result of the 1974 study called Saber Yukon, Alaskan Air Command officials decided to become part of the new Joint Surveillance System/Regional Operations Control Center program being proposed to replace air defense systems in the lower 48 states. This included new, state-of-the-art, minimally attended radars at 12 sites that required only a few technicians. Alaskan Air Command was able to restructure the base civil engineer force and eliminate hundreds of remote military tours annually and approximately 150 civil service positions.[417]

Arctic Renewal

Air Force facilities in Alaska experienced a period of renewal in the late 1980s and early 1990s under a program known as Cool Sentry. The quality of life at remote Alaskan bases such as Shemya had suffered for years with substandard dormitories, dining halls, and Morale, Welfare, and Recreational facilities. Cool Sentry improvements included better housing, modernized mission facilities, and paved roads. The $700 million MILCON and O&M programs were under the direction of Col. Ralph Hodge, Deputy Chief of Staff, Engineering and Services, Alaskan Air Command. These projects were made difficult because of the constraints of the weather, terrain, and distances. With only a narrow time window to conduct meaningful work, planning was key to the successful completion of projects. Materials had to be brought in using the joint Cool Barge program based out of Seattle, Washington, that served the Alaskan remote coastline and the Aleutians. These infrastructure and quality of life improvements were crucial in maintaining these installations for the future.[418]

Overseas Construction

Construction overseas included both improvements to U.S. bases, support to Allies, and special assignments typically generated by foreign military sales and diplomatic relationships.

Israeli Base Construction

President Jimmy Carter hosted peace talks between Egyptian President Anwar Sadat and Israeli Prime Minister Menachem Begin at Camp David, Maryland, in 1978. With the signing of the peace treaty in April 1979, Israel agreed to fully withdraw from the Sinai Desert within three years in exchange for two new bases similar to the ones Israel relinquished.[419] The final agreement stipulated U.S. assistance in building the new bases in the Negev Desert, as well as $800 million in monetary aid. The two bases, one at Ramon and the other at Ovda, were to be operational by April 25, 1982, three years after the signed treaty.[420] Expecting a treaty, the Department of Defense deployed a survey team to Israel consisting of a joint effort between Air Force and Army construction specialists in 1978. From November 1978 to May 1979, three survey teams visited Israel and helped set goals between the Government of Israel and the U.S. Government.[421]

How Air Force Civil Engineering became involved in the Israeli Air base Construction was recalled by Maj. Gen. William D. Gilbert,

> We didn't hear anything about it or have any involvement in it when the peace treaty was reached at Camp David, but about three weeks later Mr. Begin and his minister of defense came back to Washington and told Mr. Carter, "We have surveyed our industry, both from a standpoint of technical people required, construction people required, and materials required, and we cannot do those two bases in the timeframe that's allocated in the treaty. Therefore, could you help us?" Mr. Carter agreed to assign responsibility for that to DoD, and DoD made the Air Force the program manager because they were Air Force bases for the Israelis. In turn, the Air Force made me the program manager to oversee the design and the replication and the payments for that to be moved from the Sinai to the Negev.[422]

Brig. Gen. Paul T. Hartung was appointed the Deputy Director for Israeli Air Base Construction at the Pentagon level. According to Harry Rietman, General Hartung was "the Israeli Airbase Construction Program."[423] To assist with management, the Air Force established an AFRCE field office staffed by nine personnel. Their responsibilities included: providing monthly progress and management reports; approving proposed program changes; reviewing construction progress; and coordinating the final design approval with Israel's Ministry of Defense. The AFRCE field office closed on June 16, 1982 near the completion of the project.[424]

To meet the aggressive schedule, the "Fast-Track" method of construction was utilized. This method allowed construction to begin before designs were completed. Design, procurement, and construction progressed simultaneously. In fact, construction was about 30 percent by the time the total design for the bases had been completed. The Department of Defense chose the Air Force as the executive agent for the Israeli Air Base Construction Program. On July 25, 1979, a Memorandum of Understanding between the Air Force and the Army recognized the Air Force as charged with overall responsible for the project.[425] The Army Corps of Engineers was the construction agent and established the Near East Project Office within the North Atlantic Division to manage construction aspects of the program. In May 1979, the Army Corps of Engineers chose two contractors to design and construct the air bases. Contracts were granted for each base. The construction of Ramon was the responsibility of Air Base Constructors, a joint venture sponsored by Guy F. Atkinson Company of San Francisco and Dillingham Corporation, and Nello L. Teer Company in association with Trippetts-Abbett-McCarthy-Stratton. Ovda was the responsibility of Negev Airbase Constructions, a joint venture sponsored by Perini Corporation of Framingham, Massachusetts with Paul N. Howard Company and Louis Berger International, Inc. Management Support Associates provided engineering construction management and other support to the Corps of Engineers in supervising the two design and construction contractors. The company provided contract administration, program execution and cost control, and life support (housing, food, and custodial service). Workers for both sites came primarily from Portugal and Thailand.[426]

The scope of construction for the Israeli air bases included "all runways, taxiways, and aircraft aprons, aircraft shelters; operational, maintenance, administrative and personnel support facilities; electrical, water, waste, and petroleum, oil, and lubricant systems; roads; and ground improvements."[427] The construction of the bases was a unique event. The Israeli Air Force Base focus was vastly different from USAF in that Israeli bases were built "almost entirely as war-fighting platforms" and located on the front lines of defense for any conflict with adjacent neighbors. Hardened facilities and infrastructure planned to minimize response times against hostile activities were required. Most facilities were built underground, which provided the highest degree of protection for the tactical fighters and personnel.[428] Each base included ten complexes of six shelters each including supporting systems and structures and was more sophisticated than American air bases. In addition to the time constraint, engineers and contractors had to deal with harsh weather and terrain conditions. Both sites are located in remote parts of the Negev Desert plagued by high heat and dust during the long summer months. Work at Ovda required the construction of flood structures to safeguard against the possibility of flash floods, one of which occurred in December 1980. The flood control facilities worked to perfection just as anticipated, designed and constructed without any resulting damage to ongoing airbase construction.[429] Special techniques were required for constructing durable foundations on the silty terrain. Ramon is located on a "rocky plateau" and required extensive rock removal.[430] The first aircraft landed at the bases in October 1981, six months before the April 25, 1982 required date for initial operating capability. By December 31, 1981, the Intra-Agency DOD/MOD Progress Report evaluated the overall work status as 86 percent complete at Ramon and 87.5 percent complete at Ovda. All construction was completed nine months ahead of schedule.[431] General Hartung received SAME's Newman Medal in 1981 in recognition of his work with the Israeli air base project. Capt. Karsten H. Rothenberg (later Colonel), who served as executive officer and assistant to General Hartung, described the project as a huge success, "Our small, dedicated team of Air Force Civil Engineers helped deliver the state-of-the-art bases ahead of schedule, despite numerous obstacles, delays, and bureaucratic challenges and helped usher in a period of peace between Egypt and Israel."[432]

Foreign Military Sales

Air Force civil engineers assigned to the Air Force Logistics Command (AFLC) supported foreign military sales (FMS) programs by overseeing and coordinating construction to modernize and upgrade foreign air bases. Several FMS programs were initiated during the late 1970s and the 1980s. Aircraft sales to the Saudi Arabian Government were particularly active as the Royal Saudi Air Force (RSAF) upgraded its aging World War II aircraft. Under Peace Hawk, the RSAF began to acquire F-5 aircraft, and under Peace Sun, F-15s. Both programs required four phases: 1) purchase of aircraft; 2) construction of modern facilities to bed down the new aircraft; 3) establishment of a contract for maintenance; and, 4) implementation of training. AFLC served as overall program manager for the Peace Hawk program and used the Corps of Engineers to provide budgetary and technical reviews of the various projects, initially at Taif and Dhahran. In June 1975, the Secretary of Defense assigned the Air Force as the single manager for the Peace Hawk V construction program. The $480 million construction program at three sites had a compressed timeframe for facilities construction; the initial facilities were required by 1977 with completion of final facilities by 1979. AFLC established a management office staffed by civil engineers that worked closely with the construction contractor to prepare specifications, review and expedite designs, contract the work, coordinate with RSAF throughout the project, and oversee the on-site construction program.[433]

In the late 1970s, the Saudi Arabian government reduced the number of F-5s it planned to buy when it gained approval to begin purchasing F-15s under the Peace Sun program. The AFLC Director of Engineering and Services was the facility program manager to implement and manage the Peace Sun II Facilities Construction Program and for interface with the Corps of Engineers and RSAF. The Corps was designated as the program construction agent. In 1980, AFLC civil engineers worked on the team to construct air base facilities to support the Saudi Arabian acquisition of F-15 aircraft under Peace Sun II, which was also combined with the Peace Hawk VII program for more effective program management. A letter of agreement for Peace Sun II was signed with the Saudi Arabian Government on February 10, 1980. Brig. Gen. Charles W. Lamb, the Deputy Chief of Staff for Engineering and Services at AFLC between 1976 and 1981 served as the initial facilities program manager for the more than $2 billion project. Then-Brig. Gen. M. Gary Alkire, followed General Lamb at AFLC and as program manager and assured completion of the Peace Sun II projects and an efficient start to Peace Shield.[434]

Peace Shield began during the early 1980s. Under Peace Shield, the RSAF purchased Airborne Warning and Control System (AWACS) aircraft, as well as a ground-based command, control, communications, and intelligence system. At the explicit request of the Saudi Arabian government, the U.S. Air Force served as the contracting agent for the Peace Shield and on June 10, 1982, the Office of Secretary of Defense approved the Air Force as the DoD construction agent for the program. Brig. Gen. David M. Cornell, who became the Deputy Chief of Staff for Engineering and Services at AFLC in March 1984, managed the Peace Shield program. The Peace Shield program was, at the time, the "largest Air Force-managed design and construction program ever" and included renovation of an existing command operations center, two and construction of five underground hardened 10,000 square meter command/control centers, two base operations centers, ten ground entry stations, one central maintenance facility, 17 long-range radar sites, 33 communication site facilities and miscellaneous equipment shelter facilities. The initial cost estimate for facilities construction was $696 million.[435] All of this was scattered throughout Saudi Arabia and meant challenging oversight issues. AFLC civil engineers worked closely with contractors to complete the design process, contract the work, provide engineering and inspection services, and oversee on-site construction of the program. In fact, members of the Peace Shield team were in Riyadh when Operation Desert Shield began in 1990. When the program had been completed in 1992, the team had delivered high quality construction projects on time and within budget.[436]

Project Peace Pharaoh was another FMS program in 1979. The goal of Project Peace Pharaoh, a $5 million construction effort, was to organize the transfer of 35 USAF F-4E planes to Egypt in 1979. It was discovered, only weeks before the scheduled delivery of the aircraft, that the Cairo West Egyptian AFB was not properly equipped with electrical power to maintain the aircraft. The construction aspect included wiring a large hangar and upgrading the electrical wiring at a missile facility, a schoolhouse facility, and a flight simulator building. Prime BEEF team 79-42 was established with five personnel. They were sent to the Egyptian AFB to determine what was necessary in order to appropriately modify the system. The team designed the electrical system upgrade and assembled a list of needed materials. Their design took 14 days to create; there were no surrounding sources for materials and the AFB had no on-base civil engineering support. When the Prime BEEF 79-42 team returned home, Prime BEEF team 79-43 was created with the specific mission of actually putting the system in place. This team was created by asking the major commands for qualified personnel. The 18-person team gathered for deployment in October. There were representatives from 17 AFBs. A C-5 delivered the Prime BEEF team along with 100,000 pounds of equipment. Within five days, a C-141 deployed to supply the team with more materials. The team installed 16 miles of cable in 3 miles of conduit, 314 branch circuits and 12 different transformer banks.[437] The project was a success, despite the many supply shortages and incompatibility issues.[438] A follow-on project known as Peace Vector I involved the sale of F-16 aircraft to the Egyptian government. The Egyptian Air Force requested assistance in upgrading facilities at An Shas Air Base to support the F-16 beddown. AFLC, working through the Corps of Engineers, was responsible for the mechanical and electrical design work at the site. Throughout 1982, Prime BEEF personnel deployed to An Shas AB to provide construction management functions on utility systems and operated a newly completed power plant.[439]

Southwest Asia Basing and NATO

Civil engineers assigned to the overseas commands were charged with managing and directing construction projects. When the Shah of Iran was deposed by Ayatollah Khomeini in the fall 1979, the United States lost an ally in the region and gained an adversary. In response to the change of leadership in Iran, the United States sought new alliances with countries in Southwest Asia. In March 1980, the United States established the Rapid Deployment Joint Task Force (RDJTF), which became the U.S. Central Command in January 1983. The RDJTF was focused on the Persian Gulf Region. One goal of the RDJTF was to establish infrastructure accessible to the United States in the region from which to launch attacks and to recover aircraft in case of armed conflict. Initially, governments were reluctant to permit U.S. bases in their countries. As Maj. Gen. Joseph A. Ahearn recalled,

> I was in the programming shop [at the Pentagon] when we started planning the basing network for the Middle East when [Ayatollah] Khomeini took over Iran in the fall of 1979, after the fall of the Shah. I recall running trips all through the Persian Gulf and being told “No” by every nation in the Persian Gulf except for Oman. The reason Oman told us okay was because they had a remarkable relationship with the Brits. British generals were actually the Secretary of Defense for Oman and the Chief of Staff for the Sultan of Oman. They held positions of foreign policy influence, and the Brits were into nation building in Oman. Of course, the Brits are very close allies of ours, and they understood that we needed to have basing and logistics storage and things of that sort. So, we budgeted the building of four major bases in Oman: Masirah Island, Seeb, Thumrait, and the other one was Khasab. There’s a knob that narrows down, going into the Persian Gulf. It’s a mountain, and embedded in the side of the mountain is a C-130 special operations base that we

> built….Then we won a little bit more of a concession out of Bahrain and more out of the United Arab Emirates. We were also building foreign military sales cases and remarkable air bases for Saudi Arabia.[440]

When General Ahearn was posted to USAFE as Director of Engineering and Services in 1983, he was charged to execute the Persian Gulf basing network. As he reminisced,

> Then when they sent me forward, they gave me the [Persian Gulf basing] program to execute. So, putting into place the basing network in Egypt, Saudi Arabia, Oman, Bahrain, and the United Arab Emirates—getting the basic network, the en route basing and then the logistic basing at Oman and then the forward basing—that was quite a program we put together. We did that with foreign military sales cases, through major collaboration with the Army Corps of Engineers, using the in-country relationships.[441]… The Persian Gulf basing network and the upgrades to NATO bases in places like Turkey provided necessary platforms used at end of the 1980s during Desert Shield/Desert Storm.[442]

<u>Ground-Launched Cruise Missiles</u>

NATO began planning the deployment of the USAF Ground-Launched Cruise Missiles (GLCMs) in 1979 in order to challenge U.S.S.R Intermediate Range Missiles, such as the SABER. Five NATO countries participated with six installations: Royal Air Force (RAF) Greenham Common and RAF Molesworth, in the UK; Comiso Air Base, in Italy; Florennes Air Base, in Belgium; Wüschheim Air Base in West Germany; and Woenstrecht Air Base in the Netherlands.[443]

According to General Ahearn, who served as Chief of Programs Division at Headquarters U.S. Air Force and later oversaw GLCM construction with USAFE, the creation of bases to support GLCMs overseas:

> was the first time I saw NATO aligned to do anything…we had to win the will of those nations to put them in, because those were nuclear weapons. We got the will and then we had a finite amount of money. It was a NATO-funded program. There was a finite amount of resources coming out of the NATO world, and there was a finite amount of resources appropriated by the U.S. Congress to support our forces to operate those sites.[444]

The project cost over $1 billion to implement. Engineering the facilities was complicated by a short timeline, the design and construction of highly technical missile shelters and the political issues generated by NATO. The first activated installation was the RAF Greenham Common in England. In addition to missile launch and missile support facilities, dormitories, administrative offices, and engineering workspaces were required. Each missile facility required 20,000 tons of concrete and approximately 1,000 miles of steel reinforcing rods. Doors on the facilities weighed 80 tons. GLCM construction necessitated the creation of GLCM Alert and Maintenance Areas.[445]

Construction at Comiso base, located in Sicily, was particularly challenging for the Air Force civil engineers because it entailed rebuilding an entire base that had been deserted since the end of WWII. Buildings at the base had to be demolished in order for work to begin on the GLCM site. Approximately 2,000 Air Force personnel were expected to populate the base. The project was organized by USAFE Engineering and Services in conjunction with the Navy Office in Charge of Construction for MCP and the NATO host nation. In September 1982, construction began on dormitories, a dining hall, and other support facilities. Services managed dining and housing for the initial workforce while preparing for the projected sizeable increase in arriving personnel. Engineers were responsible for overseeing construction and establishing base civil engineering. There were time limitations, site confines, and financial restrictions. In addition, the ever-changing technology of weapons systems created an environment of innovation and constant change. Air Force civil engineers showcased their ability to be flexible while maintaining an organized program.[446]

USAFE Readiness Initiatives

Building on the shelter program of the 1960s and early 1970s, USAFE embarked on a significant set of readiness initiatives beginning in 1974. These projects helped ensure the survivability and operability of the basing system throughout the continent in the face of an increased Warsaw Pact threat. Some of the initiatives included hardened aircraft shelters; hardened base and command operational facilities; revetment, comouflage and dispersal measures; collocated operating base development, and contingency launch and recovery capabilities. USAFE engineers began construction of new Third Generation design shelters that could accommodate all planned and current U.S. tactical fighter and reconnaissance aircraft. The primary change in the shelters was the front closure was no longer recessed to maximize protective internal floor space. The initial $54.5 million program for 87 shelters was placed under contract in June 1975 and completed in only 18 months. USAFE also provided significant hardening of facilities at various bases and included construction of a Combat Operations Center at Ramstein AB, West Germany. Engineers also improved survivability through the CREEK PROTECT initiative to provide exterior revetments of existing facilities and a tonedown of base infrastructure and airfields. In all, these programs represented a $1 billion investment.[447]

USAFE maintained a system of main operating bases in Europe; construction and operations and maintenance funds were controlled through the USAFE Director of Engineering and Services. In addition to main operating bases, USAFE civil engineers continued to establish a series of collocated operating bases (COB) in host nations that were available to bed down deploying U.S. troops in case of enemy attack. When needed to accommodate deployed troops, the facilities at COBs were expanded through the construction of tent cities, construction of expanded runways, augmentation of fire protection services, and construction of protective structures.[448] COBs in Europe increased to 60 by 1984 with plans to add more in Greece and Turkey.[449]

Another aspect of readiness preparation in USAFE was the distribution of NATO Prepositioning Procurement Packages at main operation bases, COBs, and aerial ports of debarkation. This effort resulted from a request by the Office of the Secretary of Defense to reduce airlift requirements early in deployments. Types of prepositioned equipment were heavy items that required little maintenance and could be stored for long periods of time. The purpose of the prepositioned packages was to have certain types of equipment ready and available in theater-of-operations areas without having to ship it via 600 cargo plane loads. By 1988, prepositioned equipment was stored at 75 sites to support 85 locations.[450]

While some nations accepted COBs, other nations were reluctant to allow foreign military bases to occupy their soil. For these situations, "Bare Base" was developed. Under Bare Base, the Air Force constructed, with host nation approval, basic operating surfaces, such as a runway and pavements and an established potable water supply. All other materiel was flown to the base when required. Other materiel included tents, latrines, mess facilities, and operations structures to support deployed troops. During the 1970s and 1980s, these kits were known by the Air Force as Harvest kits. This equipment had been upgraded and modernized to replace similar equipment used in Vietnam.[451]

The development of Harvest Falcon began in 1979, using elements of the Harvest Eagle and the Harvest Bare. People from the support side of the Air Force gathered together in a series of Bare Base Enhancement Conferences to discuss requirements for Harvest Falcon. The goal of the conferences was to develop a deployable package to bed down 750 aircraft and 55,000 personnel in 13 different locations. The development process was restricted to items that already existed in the previous Harvest kit packages or were readily purchased from commercial suppliers. The basis of Harvest Falcon was a Harvest Bare kit designed to accommodate 4,500 persons. During 1981-1982, sections of Harvest Bare assets were used during a deployment to Egypt named Proud Falcon to house several thousand troops. This deployment was a training exercise to teach the Egyptians to fly F-16 aircraft.[452] The Air Force used Harvest Bare assets during Operation JUST CAUSE, the 1989 American incursion into Panama to remove General Manuel Antonio Noriega from power. In 1991, AFCESA sent a team to Howard AFB, Panama, to examine the Harvest Bare equipment's condition for reconstitution or disposal. Eventually, much of the equipment was sent to Tyndall to be used for training purposes because it was no longer in a worldwide deployable condition.[453]

Between 1980 and 1990, approximately $1 billion worth of additional assets were added to the kit until it could accommodate 55,000 persons. Then the material was packaged in increments to sustain 750 people up to 15,000 persons.[454] Harvest Bare featured hard wall facilities to allow specific environmentally controlled spaces such as laboratories and medical clinics. Harvest Falcon included both hard and soft walled facilities and the kits were placed in packages that were more easily deployable. Harvest Falcon kits weighed less and were easier to airlift than the Harvest Bare assets. The new bare base assets included "vehicles, engineer equipment, communications gear, medical facilities and equipment, user unique tactical shelters, mobile flightline maintenance equipment, tanks, racks and pylons."[455] Harvest Eagle featured heating as the only environmental control; whereas, Harvest Bare and Harvest Falcon utilized HVAC. Harvest Falcon was designed exclusively for Southwest Asia campaigns and did not provide freeze protection.[456]

All Harvest kits were categorized as War Materiel Reserve. TAC, USAFE, and PACAF were assigned four Harvest kits each. Two kits were required to be pre-positioned to be deployed within 72 hours of notification, while the other two sets had to be available within 30 days. TAC's packages were available for deployment worldwide, while USAFE and PACAF Harvest kit assets were only for theater deployment.[457] By 1990, Harvest Falcon assets also were prepositioned in Oman and other locations in southwest Asia and played a critical role in the Gulf War.[458]

EDUCATION AND TRAINING

Professional Development

AFIT Short Course Program

The civil engineering short course program continued to expand under the leadership of the Deans, Cols. James S. MacKenzie and Oren Strom in the mid-late 1970s. Critical to their expansion plans of the technical and management short courses was the need to significantly renovate Building 125 at Wright-Patterson AFB, Ohio, AFIT's home since 1948. In response to the overall emphasis on energy conservation after the Arab oil embargo in 1973-1974, the Civil Engineering School introduced a short course on solar energy, and other courses such as Contemporary Energy Applications and Facility Energy Systems. The school also added significant emphasis on energy conservation initiatives in their electrical and mechanical courses.[459]

Facilities Management Program

Civil engineering was among the most highly educated disciplines within the Air Force during the 1970s. By 1975, 40 percent of Air Force civil engineer officers held masters degrees and only one percent of civil engineer officers lacked a college degree.[460] The professional caliber of Air Force civil engineers was advanced through programs providing educational opportunities and supporting professional advancement.

Education was not limited to engineering; training in related fields prepared personnel for management, administration, and a variety of allied fields. As Maj. Richard M. Bierly, with the Air Force Military Personnel Center, noted, "in today's environment, today's competence rapidly becomes tomorrow's obsolescence…for the future middle and senior Engineering and Services manager, an advanced degree in management will more adequately prepare the officer to assume supervisory and management responsibilities." Major Bierly, who served as Chief of Engineering and Services Career Management Team, also recommended that officers become registered as Professional Engineers, echoing the words of General Minton from the early 1960s.[461]

Between 1973 and 1977, 86 students graduated with Master of Science degrees awarded by AFIT's Facilities Management Program. This program was established to provide graduate level educational opportunities for both officers and comparably ranked civilians in civil engineering management. The degree program, which required a year commitment divided over five quarters, included coursework in computer programming, accounting, writing, statistics, management, and research.[462] The three main prerequisites for officer admittance into the program were "three years working experience in civil engineering, an undergraduate grade point average of 2.50 on a 4.00 scale from an accredited institution, and an acceptable score on the Graduate Records Examination (GRE) or Graduate Management Aptitude Test (GMAT)." Civilians entering the program were required to "possess a baccalaureate degree in engineering, and complete either the GRE or the GMAT." Civilians with degrees in fields other than engineering could substitute relevant and substantial work experience in civil engineering. In addition, civilian applicants for the program were required to apply directly to the AFIT Director of Admissions to determine their eligibility for entrance. Once they were determined eligible, civilian candidates secured nominations for program admittance from the BCE and the base or wing commander. Nominations then were forwarded to the major command for endorsement by civil engineering staff. If selected for admission, civilian applicants were required to commit a minimum of three years to the Air Force following graduation.[463]

By 1980, 150 candidates had graduated from the USAF Graduate Facilities Management program with Master of Science degrees. The same year, the name of the program was changed to Graduate Engineering Management (GEM) and the period of coursework was increased from 12 months to 15 months. The extension allowed students to devote more time to thesis projects. Students were allowed 12 hours of research dedicated to their thesis topic; if the topic was complex or time consuming, two students could work together on one project. The GEM program was endorsed by the Accreditation Board for Engineering and Technology in 1982.[464] Brig. Gen. James T. Callahan, commander of AFIT at the time, justifiably bragged that the accreditation was "recognition of the quality of that curriculum by the professional engineering community."[465]

Education with Industry

Education with Industry (EWI) was a unique program offered to USAF officers, which allowed personnel to team with private industries to better understand management and operations. In addition, the program provided opportunities to compare the operations of private industries and those of the military. In many instances, this experience provided officers with a fresh outlook to bring an added dimension to projects executed later in their Air Force careers. The types of industries invited to participate provided appropriate experiences for civil engineers and Services personnel, including commercial airports, planning offices, construction firms, hospitality corporations, food industries, and even retail operations. One industry collaborator placed students in facilities management at the Dallas Fort Worth Airport (DFW). Brig. Gen. Archie Mayes, then retired from the USAF and working for the airport, supervised students participating in the program at DFW. Capt. Thomas M. Riggs wrote about his experiences in EWI at DFW, stating that his "time spent in facilities maintenance centered around hands-on experience with each of the maintenance shops." Captain Riggs was exposed to the technical aspect of repairing and maintaining runway lighting, as well as to the operation of a steam utility plant. The EWI program provided a good opportunity for students to understand management and operations outside of the military.[466]

PhDs

During the 1980s, Air Force Engineering and Services recognized the advantage of PhD-level commissioned officers and supported candidates seeking terminal advanced degrees. Although the need for personnel holding Masters Degrees was greater, PhDs were becoming more essential with advancing technology and the concentration on research and development. A study of Air Force Engineering and Services tracked 33 jobs requiring civil engineer officers holding PhDs in 1986. At the time only 13 applicants fulfilled the qualifications for the positions. Typically, a PhD involved three years of coursework. Following completion of the degree, three years of active duty were required for each year of education, not to exceed five years.[467]

Civilian Career Program

The Engineering and Services Civilian Career Management Program (ESCCMP) was designed to support career advancement for executive-level civilian employees (GS-12, GS/GM 13-15) in the Air Force similar to Palace Blueprint, a career management program for Air Force officers. Harry P. Rietman, a member of the Senior Executive Service, and civilian Associate Director of Engineering and Services (1973-1985) in the Pentagon, explained,

> Prior to the establishment of ESCCMP, somebody with a lot of foresight in the Personnel field saw that the civilian component of the Air Force didn't have the career progression or the training opportunities or the same benefits that military people had. We didn't get the benefit of people who were talented and capable, nor did we have the ability to move them into more responsible positions on an orderly basis, rather than on a haphazard basis based on who you were, where you were, and who you knew…There was no central location (to find executive civilian jobs). If a vacancy occurred either in the commands or at the bases or at the headquarters there was no central place you could go. You advertised and hoped that the best people applied for it. If the person didn't apply or didn't know about the advertisement, which was also a very common thing, it was as though they didn't exist… You were really geographically handcuffed, except for your own individual volition. If you went out and looked and talked you could find opportunities, but they weren't very evident and many of them you might never hear about. You had no way of knowing, for instance, that PACAF needed a senior civilian if you worked in Europe.[468]

By 1980, Air Force Civil Engineering had 32,000 civilians working within the organization.[469] Maj. Gen. William D. Gilbert initiated ESCCMP in November 1980 with the establishment of a Policy Council. A working group of top people from the Engineering and Services community met for two weeks in February 1981. This group analyzed the work force, recommended basic program policy, and prepared a working draft of an Air Force regulation (AFR 40-110, Vol. VII). The work generated from this two-week session was reviewed by the Policy Council in April 1981. The Policy Council worked throughout 1981 and 1982 and continued under the directorship of General Wright. By fall

Mr. Harry P. Rietman

1982, six employees comprised the ESCCMP Palace Team and were located at the Office of Civilian Personnel Operations at Randolph AFB, Texas.[470]

Under the program, eligible civilians in executive positions were registered through their Civilian Personnel Officers with the ESCCMP by entering personnel forms into the Personnel Data System-Civilian. Registrants' personnel profiles were then analyzed applying Air Force-wide promotion evaluation patterns. When a major command, base, separate operating agency, or direct reporting unit required a top-level civilian position, a request was sent to ESCCMP, which reviewed the civilian personnel list to identify qualified candidates. A roster of certified candidates then was returned to the requesting agency. A sample of the executive positions included in the original ESCCMP included community planner, environmental protection specialist, general engineer, architect, civil engineer, environmental engineer, electrical engineer, realty specialist, housing/billeting positions, and services officer.[471]

The first referral of qualified applicants was made in May 1983 to fill the position of deputy base civil engineer at Scott AFB, Illinois. A pool of ten candidates was identified from four commands. Eight of the ten names were employed outside Scott AFB. Col. Wesley D. Nottingham, the BCE at Scott AFB commended both the timeliness of the program's response and the quality of the candidates for the position. In June and July, qualified applicant names were submitted for an additional 15 open civilian positions throughout the major commands. The advertised positions covered about 60 percent of the types of positions covered in ESCCMP; a total of 968 positions were covered in the program.[472]

The ESCCMP established a central office to match job positions with qualified civilian employees. The program also offered civilian employees a clear picture of Air Force system performance expectations and requirements for promotions.[473] The ESCCMP team formulated master development plans and career patterns outlining the positions available for progressive advancement in fields included in the program.[474] Master development plans were available to registrants devising career development plans.[475] These development plans served as a tool for employees and supervisors to identify career goals and appropriate training.[476]

The ESCCMP also offered a centralized funding source to underwrite training and education, particularly in the areas of managerial and executive development.[477] The first training programs were scheduled during FY85.[478] In 1984, three ESCCMP registrants were enrolled in the AFIT Graduate Engineering Management Program; twelve ESCCMP registrants attended in 1985.[479] In 1986, the Air Force entered into a relocation services contract to aid in the mobility of ESCCMP registrants in GS-12 positions and higher.[480] In addition, the AFIT technical and managerial short courses were open to civilians.

In addition, an intern program for civilian employees in GS-5, -7, and -9 levels was implemented FY85 during the recruitment for 18 engineer/architect positions. By fall 1985, two housing management interns were selected from among 97 applicants. Interns participated in a variety of planned developmental activities designed to broaden their experience with all levels of the Air Force organization. While relocation to other bases was not a requirement for participation in the ESCCMP program, mobility was required for the intern program. In 1985, interns were recruited for one real property, two housing, and two Services positions through the ESCCMP.[481]

In 1985, the ESCCMP Career Guide was published and distributed to all registrants in the program. The guide provided comprehensive information on the ESCCMP program.[482] The guide also was a useful tool for supervisors to introduce new employees to ESCCMP.[483]

Technical Training

Sheppard AFB, Texas, had been the home of civil engineer technical training since 1958. By 1976, the training group was engaged in training personnel in basic, lateral, supplemental, advanced and special courses in support of four Air Force Civil Engineer career fields: Airman Metal Working; Airman Civil Engineering Mechanical/Electrical; Airman Civil Engineering Structural/Pavements; and Airman Civil Engineering Sanitation. Also that year, the Interservice Training Review Organization decided to collocate certain civil engineer courses with the Army at Fort Leonard Wood, Missouri. In 1983, instructors taught 73 courses ranging from the 4-day Snow Removal and Ice Control Equipment course to the 55-day Engineering Assistant Specialist and Construction Equipment Operator courses (taught at Fort Leonard Wood). The nature of the courses was constantly changing in response to real-world conditions and advancements in technology. Electronics had become so pervasive that about 45 percent of the courses contained training in electricity and electronics. In 1989, Sheppard instructors taught 16 specialty awarding courses. The courses available included a 7-day coal handling course taught by an instructor at the home station; a 10-day advanced water treatment course; a 20-day course on heating, ventilating and air conditioning systems (where students balanced air and water distribution systems); a 3-day Harvest Bare staff orientation course taught by a traveling instructor, and an 80-day resident course on civil engineering electronic systems. The school also had nine mobile training teams that traveled to bases at no cost to the unit. Approximately 7,500 people graduated from Sheppard's courses each year at the close of the 1980s.[484]

Fire School

The fire school at Chanute continued to develop new courses and revise its curriculum throughout the 1970s and 1980s. New courses focused on mobile training and new equipment such as the new P-15 Aircraft Crash Fire Fighting and Rescue Vehicle. In 1978, the Army Fire School at Fort Rucker, Alabama closed and the first firefighting joint training began at Chanute Technical Training Center, Illinois.[485] By 1978, the Fire Protection Training School at Chanute enrolled 4,000 personnel in educational programs for the year. The training covered a range of skills from the basics of fire protection to the advanced firefighting capabilities necessary for engineering and technology. Approximately 1,500 U.S. Air Force personnel entered the basic program annually. Maj. Gen. Norma E. Brown, Commander of the Chanute Technical Training Center, provided superb support to the school and often came to the school to meet students in a variety of classes. The sophisticated incident management training simulator used at the school was renamed as the Norma Brown Air Force Base Simulator and used for more than 30 years to honor her contributions to the school.[486]

Readiness

Contingency Forces and Training (Prime BEEF, RED HORSE, Prime RIBS)

During the decade of the 1980s, an increased focus on readiness permeated the Air Force civil engineering organization and efforts were made to strengthen the links between the daily role of Civil Engineer and Services personnel and the overall mission of supporting combat forces when deployed.[487] Time to establish logistics support services overseas once a war had started was a past luxury. War contingency planning required that military personnel master their wartime jobs, continually train for those assignments, and be well equipped for overseas deployments. [488] General Gilbert summarized the importance of operating and maintaining a base while continuing the training necessary to support a wartime mission,

> as important as our other day-to-day jobs might be, they are secondary to preparedness for the conduct of military warfare…our military personnel must be totally aware of the fact that their peacetime job exists only because we need them on-board and ready at all times to do something else. This applies especially to our senior and mid-level NCOs and officers. No one—including BCEs and Services Squadron Commanders—are exempt from preparedness and its required training.[489]

Civil engineer responsibilities during wartime were defined as emergency repairs to essential facilities and utilities damaged during war, rapid runway repair (RRR), bomb damage repair (BDR), preparing and maintaining bases to receive deployed personnel and equipment, and crash rescue and fire suppression.[490] During the late 1970s, Prime BEEF was divided into six contingency teams. (Table 4.1)

A program to develop a contingency force for Services personnel began in 1978. Patterned after the Prime BEEF program, the new capability was called Prime Readiness in Base Services (Prime RIBS). Col. Paul Hartung, then the deputy chief of staff for Engineering and Services at HQ Military Airlift Command, was one of the leaders in pushing for this capability and also the person who coined the term Prime RIBS.[491] The program created teams with the mission to feed, house, and clothe USAF units that were deployed. In 1979, the Prime RIBS teams were configured into four different types. (Table 4.2)

By 1979, training requirements for Prime RIBS teams were under development to guide home station and field training exercises. The first group selected for field training comprised graduates from Lowry Technical Training Center's Services School who were assigned to U.S. Air Forces in Europe (USAFE).[492] In January 1980, a week-long field food service course held in conjunction with Prime BEEF training was conducted at Eglin AFB, Florida.[493] The field training comprised two days of hands-on training and two days of meal preparation for Prime BEEF personnel.[494] The one-week course marked the beginning of Prime RIBS training to equip Services personnel in field operations using field equipment in preparation for deployment.[495] Experience gained through the establishment of Prime RIBS resulted in the development of new mobile kitchens, food preparation and serving systems, and mobile laundry systems.[496]

By 1982, home station training for Prime RIBS teams included "annual field and food handler sanitation training…survival training in a nuclear, biological, chemical environment…annual field

Table 4.1 Contingency Force Prime BEEF Teams and Duties

Contingency Force Prime BEEF Teams	Duties
CF-1	21 pavement maintenance specialists & equipment operators headed by an officer; nucleus for RRR…For RRR and BDR, the CF-1 team is matched with a CF-2 team.
CF-2	4 officers, 66 enlisted specialists as found in a CES; complements a CF-1 team to form a 91-man RRR force, or can be deployed independently if a small bare base or general purpose civil engineering force is needed.
CF-3	2 officers, 33 specialists; performs emergency construction management; supplements CF-1 & CF-2 teams; 2 CF-3 teams can be matched with 1 CF-1 team to perform RRR.
CF-4	15 officers, 5 NCOs; command & staff element; can be deployed independently; is not located at one specific base…The CF-4 team may be drawn from several different bases or staff elements and is the only team which is not located at one specific base. This team deploys independently from other teams.
CF-5	12 crash rescue and fire suppression operations specialists; 2 or more teams can be matched with a CF-6 team to form a firefighter organization.
CF-6	3 7-and 9-level NCOs; firefighter command and control element; deploys independently; can deploy with 2 or more CF-5 teams to form a BCE organization.

Source: Maj. Max W. Day, PE and Lt. Col. George T. Murphy, "Prime BEEF and Prime RIBS: The Wartime Role of Engineering and Services," ESQ, Vol 20, No 4, November 1979, 19.

training on field food service equipment; mortuary affairs search and recovery training; and annual small arms weapons qualification."[497] Field training included periodic mobility training sponsored by AFESC once every 24 months at Eglin AFB, Florida; Holloman AFB, New Mexico; or, Ramstein AB, West Germany. The goal of mobility training was to expose Prime RIBS personnel to actual field conditions with actual field equipment. Prime RIBS personnel operated field kitchens and prepared B-rations, operated field laundries, provided billeting services, and conducted mortuary affairs.[498] On-the-ground training was augmented through the development of "The Prime RIBS Manager's Handbook" (Air Force Pamphlet 140-3), the "Food Service Field Feeding Handbook" (AFP 146-1), and additional training materials.[499]

Table 4.2 Contingency Force Prime RIBS Teams and Duties, during 1979 planning stage

Contingency Force Prime RIBS Teams	Duties
A	40 all-service specialists; supports a population up to 400 personnel at COBs, bare, standby or limited bases with no existing services organization.
B	24-man team to support Team A; supports an additional 400 people.
C	9-man team supplements Teams A & B or augments an existing services organization at a main operating base; supports an additional 450 people.
D	21-man command and supervisory team; augments a main operating base that has increased population by 900 or more.

Source: Maj. Max W. Day, PE and Lt. Col. George T. Murphy, "Prime BEEF and Prime RIBS, The Wartime Role of Engineering and Services," ESQ, Vol 20, No 4, November 1979, 19.

Prime RIBS Emblem

By 1982, the Prime RIBS program was considered wartime ready. A fall 1982 article in *Engineering & Services Quarterly* explained that Prime RIBS units were utilized for "rapid or short-notice deployments…they should not be tasked to augment other wartime functions."[500] In addition to providing food, housing, and clothing, they were also prepared to provide laundry and mortuary facilities. Prime RIBS units were equipped to handle a variety of base types, including Bare Bases, Collocated Operating Bases, Limited Bases, Main Operating Bases, and Standby Bases. Prime RIBS teams deployed to bases lacking proper equipment and were provided with one of three types of packages—the Harvest BARE, the Mobile Kitchen Trailer, or the Harvest Eagle. The Harvest BARE and the Harvest Eagle both included equipment to provide laundry and mortuary services.[501] By the mid-1980s, Prime RIBS teams were organized into four types of teams (Table 4.3).

Civil engineers teamed with the Air Force Management Engineering Agency in 1980 to conduct a two-year Civil Engineering Wartime Manpower Requirements and Posturing Study. This was the first long-term look at the wartime manpower needs of a support function that considered home station and theater wartime requirements. The results validated a significant civil engineer wartime shortfall that would have a serious impact on civil engineers' flying mission support capability. The study also highlighted a problem with the correct skill mix on Prime BEEF teams. Using the results of this study, planners developed a revised skill code composition for new Prime BEEF teams to match theater requirements. A CONUS Sustaining Study also identified the resources needed in the continental United States to sustain wartime operations. Making maximum use of the civilian workforce to accomplish minimum indirect combat support tasks, would reduce the shortfall of military civil engineers. This information was used to restructure Prime BEEF teams and correct the skill mix problem.[502]

By 1984, Prime BEEF teams were reorganized to incorporate a more varied group of skills. Large teams were broken down into smaller teams, and additional heavy equipment was incorporated. Core teams included two management teams (engineer management and fire protection management) and four basic operations teams (basic support, limited support, RRR operators, and fire protection

Table 4.3 Contingency Force Prime RIBS Teams and Duties, after 1985 restructuring

Contingency Force Prime RIBS Teams	Duties
PR-1	Initial food service supporting 500 personnel at any type base which does not have an existing services organization.
PR-2	Primary building block augmentation food service team supporting population increases of 500.
PR-3	Food service team used to support 300 personnel at small locations.
PR-4	Initial services team used for billeting, field laundry, and mortuary affairs support for 500 personnel.
PR-5	Primary building block augmentation services team supporting population increases of 500.
PR-6	Services supervision, supports population increases of 2,500 at main bases, bare bases or COBs; and augments theater command staffs.

Source: MSgt. Jim Halvorson, "New Prime RIBS Mobility Team Structure," ESQ, Vol 26, No 3, Fall 1985, 17.

operations). Specialty teams included 19 groups, which included electrical teams, and teams specializing in heating, pavements, metals, plumbing, entomology, and production.[503]

However, this framework had problems and did not last long. MAJCOMs followed a policy that required a 100 percent fill and an exact match to AFSCs, otherwise it was not postured. Instead, theater mobility requirements were satisifed through the use of three-person specialty teams. Within SAC, this meant a total of more than 2,500 military engineers without wartime taskings and the creation of more than 1,000 three-person teams within the command, an administrative nightmare and loss of credibility for engineers who were wanting increased manning to meet theater requirements. General Ellis, then the Deputy Director of Engineering and Services chartered a Tiger Team to address the concerns. The Tiger Team developed a proposal to restructure civil engineer mobility teams into four team sizes of 50, 100, 150, and 200 personnel. The standard 200-person team would be formed from existing civil engineering squadrons or by combining no more than two of the smaller teams. This reduced the number of teams from more than 3,600 to 219. The revised structure went into effect on October 1, 1987. In addition to reducing the number of mobile units, the new structure helped match the existing peacetime command and control elements, and maintain unit integrity. The Prime BEEF teams would train in peacetime as they would deploy and work in wartime and be dedicated to a specific flying squadron. The restructured force gave increased flexibility by ensuring adequate engineering support over a wide range of possible employment situations.[504]

During the late 1970s through the 1980s, the USAF strove to provide more accurate and realistic training for its personnel. In particular, training for Prime BEEF Contingency Forces personnel centered on new readiness exercises at Field 4, a deserted airfield at Eglin AFB in Florida and conducted by members of Detachment 2, AFESC. Prime BEEF teams were exposed to a five-day Base Recovery After Attack (BRAAT) exercise, which included a range of skills from basic tent erection to the construction of revetments and the installation of runway lighting. They also trained in RRR to repair craters created by explosives to resemble bomb damage. In addition to hands-on training, students also took classroom courses where they learned about the variety of equipment and situations they could face through bare base or deployed operations.[505]

Training also covered unidentified explosive ordnance identification, handling, and safety. Base denial, including the denial of infrastructure, was also part of the readiness exercises at Eglin. Every

Civil engineers participate in rapid runway repair training at Eglin's Field 4.

facet of training was completed despite weather complications or machinery malfunction. Eventually Prime RIBS units were also assigned to Eglin AFB for training. Their initial two days of training covered field kitchen equipment operation, safety, sanitation, and organization. The final two days of Prime RIBS training were spent serving hot meals to the Prime BEEF teams at Eglin.[506]

The training cadre at Eglin was not capable of training all Prime BEEF Contingency Forces across the country. As a result, AFESC created Mobile Training Teams that toured various bases giving lectures on the same topics taught at Eglin. Other readiness training during the early 1980s included advanced and introductory demolition courses at Nellis AFB in Nevada. Both Prime BEEF and RED HORSE personnel participated in the training in order to prepare for BRAAT and denial operations. CMSgt. Joseph H. Smith with AFESC's Prime BEEF Curriculum Development Branch explained the importance of Readiness training in 1980:

> Out-manned by numerical odds favoring our Warsaw Pact adversaries, our only recourse, at least for the present, is to create a state of readiness that would cause concern to any potential aggressor…we firmly believe that if a base is to recover enough to fight back after an attack, engineering and services people will be the one factor that will make it all happen and we must be ready.[507]

Guard and Reserve

During the time period from 1976 through 1990, the civil engineering components of the Air Force Reserves and the Air National Guard (ANG) became more integrated into the Air Force Civil Engineering and Services structure based on the implementation of "Total Force." The Total Force concept was approved by the Nixon administration's Secretary of Defense Melvin Laird in 1970. Under the Total Force concept, Air National Guard and Air Force Reserve components provided the primary source of manpower to back up active duty forces in future military actions.[508] The Total Force concept became DoD policy in August 1973 when Secretary of Defense James Schlesinger declared: "Total Force is no longer a concept. It is now a Total Force Policy which integrates the active, Guard, and Reserve forces into a homogenous whole."[509]

Objectives of the Total Force Policy included:

- Increase the readiness, reliability, and timely responsiveness of the combat units and the combat support units of the Guard and Reserves, and individuals of the Reserves;
- Provide and maintain combat standard equipment for Guard and Reserve units; and,
- Implement and approve ten-year construction programs for the Guard and Reserves.[510]

The Total Force policy also proved useful to offset reduced defense expenditures for the active forces. While overall defense spending dropped to 23.7 percent of the Federal budget in 1977 as compared to 42.1 percent of the Federal budget in 1969, the budget for the Air National Guard and Air Force Reserves nearly doubled between FY68 and FY74.[511]

In 1978-1979, the civil engineering components of the Reserve Forces were reorganized into contingency force teams. The contingency force teams were identical in organization, personnel, and skill sets across the board and included active duty, Air Force Reserve, and ANG.[512]

By 1979, Reservists in Services began to train under the Prime RIBS program.[513] Early in 1979, the Air Force Reserve began to seek opportunities to train food service personnel to operate dining facilities in deployment situations. The Air Force quickly offered training opportunities to support 20 regularly scheduled training exercises that occurred that year. By the end of 1979, more than 100 Reserve food service personnel had participated in training exercises. During 1980, 60 Reserve food service personnel participated with active duty personnel, who manned four dining halls during the Empire Glacier exercise organized by TAC. Over the course of five weeks, these personnel served 7,000 meals and "gained firsthand experience in the duties, problems, and requirements encountered by Reserve cooks." Services personnel also deployed with local Air Force Reserve Prime BEEF teams. During the training season for FY81, AFRES Prime RIBS teams were deployed to 11 locations in Europe and to support all regular major command exercises.[514] ANG services personnel were available for deployment in similar situations. Sometimes ANG service personnel filled jobs of active duty Air Force personnel who were deployed on training exercises. This arrangement benefitted both the local AFB and the ANG personnel.[515]

As summarized by James P. Penn, "By 1982, the organization, training requirements, manning standards, and designed operating capabilities of Reserve and active units had completely meshed. The old images of the 'raggedy Reserve' forces had given way to accurate impressions of force capability."[516] Penn was actively involved in the training of Reserve contingency forces as Director of Services and Reserve Resources at AFRES headquarters.

The typical training program for Air Force Reserve and ANG civil engineering and services personnel was accomplished in 39 days; 24 days were spent at the monthly unit training assembly and 15 days were centered on active duty training. The 15 days of active duty training were generally deployments at active duty bases. Active duty deployments were selected from projects submitted to AFESC Readiness Directorate by the major commands. AFESC in conjunction with Air Force Reserve and ANG personnel matched projects with identified training needs. Once the projects were assigned to the Reserve forces teams, it was up to the Reserve forces commander and the base civil engineer to coordinate details. For civil engineers, that meant working on a specific construction project, such as constructing a pre-engineered building, building roads, or augmenting base maintenance shops; for Services personnel, it meant duty managing dining hall and billeting operations.[517]

One special project that involved both AFRES and ANG RED HORSE units was the bed down of RED HORSE equipment that occurred between 1981 and 1984 in Spangdahlem AB, Germany. Over a two-year period, the 307th CES (Heavy Repair, HR) from Kelly AFB, Texas; the 200th CES, (HR) Camp Perry, Ohio; and, the 201st CES Flight (HR), Fort Indiantown Gap, Pennsylvania, participated in a coordinated effort to build six large hard-ribbed warehouses. The warehouses were needed to contain 400 pieces of prepositioned RED HORSE equipment. This equipment comprised pieces ranging from pneumatic jackhammers to 40-ton cranes and vehicles. The heavy civil engineering equipment was prepositioned at Spangdahlem AB at the request of USAFE to alleviate time delays in case of war. In a wartime scenario, Spangdahlem AB was designated as a major operating base to which the RED HORSE units would be deployed. As described by the 307th CES commander Col. Walter L. Winters, Jr., of his 400 member team,

> We take with us 38 Air Force specialty codes (AFSCs) including all of the Services people essential to carrying out our mission. We also have our own limited capability to defend ourselves, complete with 60mm machine guns and grenade launchers. Our medical resource includes a doctor and two medics. A communications radio net keeps us in touch with other combat forces worldwide. To give you an idea of the Services requirement, we carry 14 cooks, a field kitchen, and enough rations to operate self-sustaining for a month.[518]

As a result of manpower studies in the early 1980s, two additional RED HORSE units were formed in the ANG in 1985. The 202d CES unit was established at Camp Blanding, Florida, while the 203d Civil Engineer Flight was formed at Camp Pendleton, Virginia.[519] In 1985, civil engineers and service personnel numbered 15,000 with close to 6,000 in the Air Force Reserve and just under 9,000 in the ANG.[520] By 1989, civil engineers and Services personnel in the Air Force Reserves were projected to increase to over 8,000, while ANG civil engineering and services personnel were anticipated to increase to over 12,000 members.[521]

Contingency training included formal training scenarios as well as deployments designed to challenge and to strengthened personnel skills. These exercises were critical to the readiness mission. Selected notable exercises and deployments from the period are highlighted below.

Bulldozer U

During the late 1970s, the Air Staff assessed its needs in order to address potential conflict in Western Europe. It concluded that rapid runway repair (RRR) was a primary responsibility of Air Force engineers. An assessment of the Air Force Reserve (AFRES) revealed a major lack of RRR training, with as many as 1,300 Contingency Force personnel in desperate need of basic training in RRR equipment. AFRES quickly agreed to create an Equipment Operators School at Dobbins AFB in Georgia, dubbed Bulldozer U. Exercises began in 1979, with trained AFRES personnel serving as instructors. The program began with salvaged equipment and three students. By 1980, approximately 200 students had successfully participated in the program. Students completed a three-phase program beginning with the basics of equipment operation and safety. Their training then intensified to teach them how to operate more complex equipment associated with the completion of RRR. During the third phase, students were placed in a designated area to perform actual base tasks that required heavy equipment. This benefitted the students by giving them hands-on training in real activities, and also benefitted the base by completing needed projects. Classes were limited to ten students to guarantee a proper ratio of teachers and students.[522] Reserve Prime BEEF and Prime RIBS were included in the training. Prime RIBS students were provided with a Harvest Eagle kitchen, which was used to feed trainees. This allowed for realistic training and efficiency, permitting the school to operate on-base without straining dining facilities or transportation routes.[523]

Bulldozer U largely relied on reservists for faculty. When they were required to serve elsewhere, the school suffered. In 1984, the school nearly closed due to a lack of instructors. As a result, the Headquarters for the Air Reserve Forces requested 12 permanent personnel slots for the school, which were approved. Although the school began with meager equipment and few students it was eventually established as a reputable and necessary program for the AFRES and eventually the Air National Guard.[524]

Jack Frost 79

During the late 1970s, the similarities between the Alaska arctic and the terrain and environment of portions of Europe and Asia were recognized as affording opportunities for readiness training. In 1979, a contingency exercise, named “Jack Frost 79,” was held at a deserted airstrip on the northwestern tip of Alaska in an area known as Clear Creek Landing Zone. Alaskan Air Command (AAC) was chosen to reactivate the landing zone as part of its contingency training. Tasks included: creation of a 4,100 foot airstrip with 24-hour runway lighting; building a base to support 150 personnel, including housing, bathing facilities, a dining hall and support facilities; and supporting resupply to approximately 10,000 Army personnel stationed in the vicinity. Personnel from AAC Prime BEEF and Prime RIBS were the key players in Jack Frost 79. The 5010th Civil Engineering Squadron from Eielson AFB in Alaska cleared the existing abandoned airstrip. The 21st Civil Engineering Squadron from Elmendorf AFB in Alaska constructed the new base, and Prime RIBS provided food services. This readiness exercise was no ordinary task, the environment presented several challenges. Two feet of snow covered the landing zone. Personnel had to adjust to temperatures reaching minus 30 to minus 50 degrees.[525]

The immediate goal of the 5010th Civil Engineering Squadron upon reaching Clear Creek on January 4 was to erect shelters to survive the elements. Snow was cleared for the construction of arctic tents. On January 9, additional civil engineers from the 21st Prime BEEF Civil Engineering Squadron arrived on-site and began working on the base. Helicopters delivered supplies, including generators and Harvest Eagle Kits. By January 12, the runway was judged suitable for aircraft; the same day, five C-130s landed at the airstrip. The C-130s delivered the last personnel of the 21st CES

Prime BEEF team as well as equipment including a fire truck, forklift, and additional Harvest Eagle kits. By January 15, Clear Creek was completely operational.[526]

"Jack Frost 79" was a success. It proved that Prime BEEF and Prime RIBS could operate efficiently and effectively regardless of the environment and also proved that AAC was ready operationally.[527]

Salty Demo

One of the most important events during the 1980s was Salty Demo, held at Spangdahlem AB, West Germany in the spring of 1985. The Air Base Survivability demonstration grew out of a research and development project for various types of pavement design for constructing an airfield and was the product of three years of planning and training in the concepts of RRR, BRAAT, and air base survivability.[528] Col. Darrell G. Bittle, who served as Director of the Airbase Survivability System Management Office during the 1980s, defined the purpose and meaning of air base survivability:

- if attacked, reduce the magnitude of the attack;
- when attacked, minimize the impact on your sortie generation critical activities; and,
- following an attack, recover from that attack in the minimum time. [529]

Air base survivability comprised five fundamentals: active defense; passive defense; recovery; command, control and communications; and, aircraft enhancements and modifications.[530]

The Air Base Survivability Systems Management Office was established in 1981 at Eglin AFB, Florida with key personnel from civil engineering; Explosives Ordnance Disposal (EOD); Disaster Preparedness (DP); aircraft operations; communications, camouflage, concealment, and deception; and, security and intelligence. This group "focused Air Force efforts on acquiring needed capabilities to perform base recovery and launch combat sorties following a ground or air attack on overseas bases."[531] In 1981, an Air Base Survivability workshop was conducted with Air Force personnel representing various offices. An Air Base Survivability master plan was written that illustrated deficiencies in the way BRAAT was then handled. The workshop identified the need for greater cooperation between Air Force operations including EOD, DP, communications and security police. BRAAT research efforts culminated in the proposal, Air Base Survivability, renamed Air Base Operability in 1986.[532]

Salty Demo was an integrated Air Base Survivability demonstration aimed at executing exercises following air base attacks and practicing new runway repair tactics.[533] According to General Wright, "Salty Demo was a program to demonstrate the feasibility of constructing an alternate airstrip and test various RRR concepts."[534] According to Maj. Gen. James E. McCarthy, Salty Demo "was designed to demonstrate 'fighting an air base' in a war with the Soviet Union—all of the air base operability and survivability aspects of it, and pilots with chem gear, alternate landing fields, and all those sorts of things. And the concept of toned-down paint."[535] At Salty Demo, "It was more than just RRR….We tested asphalts that would shed water and prevent hydroplaning. We tested runway lights and runway markings."[536]

Following an attack, civil engineers immediately needed to assess and to repair damaged runways, aprons, and taxiways. The ideal goal in 1975 was to ensure a 50 x 5,000-ft clear area for fighter aircraft within four hours.[537] RRR requirements continually changed to keep up with the revised needs at USAFE bases and changing NATO criteria. According to Joseph Smith, by the early 1980s USAF was attempting to repair 12 craters in two and a half hours. The time constraints changed over the decades from "three craters in four hours…six craters in four hours and…12 craters in four hours." The repair time began with the first attack and included the time for damage assessment as well as the time for planning repair.[538]

Rapid Runway Repair in progress at Spangdahlem AB, West Germany, during Salty Demo, 1985.

Damage assessment had to be completed in a matter of minutes to accomplish the crater repair in the specified time. Crater repair was achieved by filling the void with crushed stone and pavement debris then covering the fill with a mat to protect the aircraft from foreign object damage. Smaller areas of damage were fixed with a polymer cement and aggregate.[539]

The experiences gained at Salty Demo had long-lasting effects on the evolution of air base survivability/operability. It was “an eye opener” for many, according to Mr. Tidal McCoy, Assistant Secretary of the Air Force for Readiness Support, and pushed the Air Force to focus on Air Base Operability.[540] Another result was the acknowledgement of the importance for explosive ordnance personnel to be part of the initial assessment team following an airbase attack. After Salty Demo, USAFE was the first to move EOD from Logistics Munitions Directorate to civil engineering on May 24, 1988. The next year, Maj. Gen. Joseph Ahearn visited USAFE. He was convinced by USAFE of the feasibility for realigning EOD with civil engineering. Proponents of the realignment argued that “E&S personnel cannot begin their work of repairing operating surfaces until the EOD work is at least partially complete.… Since E&S possesses the most logical skills to augment EOD activities and have the bulk of the equipment that can be used to accomplish the EOD mission, they should accept EOD under them.”[541] By April 1991, all major commands had agreed with the proposal to reassign EOD capability to civil engineering.[542]

Another result of Salty Demo was the development of folded fiberglass mats to meet the demand for thin matting for repairing craters. The traditional AM-2 matting caused too great a degree of disturbance during aircraft take off and landing. R&D personnel never fully endorsed the USAFE method for concrete slab repair that had been developed by the Federal Republic of Germany. While R&D worked on the fiberglass mat, USAFE tested the concept and found that the solid fiberglass mat had merit. The R&D program developed 16’x30’ sections of fiberglass that “folded up like an accordion.” After the development of the fiberglass mat, USAFE phased out the use of concrete slabs.[543] The folded fiberglass mat system received final approval from the Tactical Air Warfare Center in 1990. The mat was a result of nearly eleven years of research by the ESL and Navy CE Laboratory.[544]

Readiness Challenges

In the early 1980s, USAFE sponsored a series of RRR competitions to help perfect this critical wartime skill. In 1983, Air Force Logistics Command (AFLC) and Air Force Reserve picked up on the idea and carried it a step further. The two held the first CONUS Prime BEEF Rodeo at Hill AFB, Utah, which was won by the team from Wright-Patterson AFB, Ohio. In October 1984, Air Force Reserve hosted an expanded Rodeo at Dobbins AFB, Georgia, that included 15 teams from Tactical Air Command, Military Airlift Command, and the Air Force Academy, in addition to the AFLC and AFRES competitors. Engineers competed in seven different events such as Force Beddown, Explosive Ordnance Reconnaissance, Equipment Operations, and RRR. The McClellan AFB, California. team came out on top.[545]

During the mid-1980s, personnel from the Air Force Engineering and Services Center at Tyndall AFB, Florida initiated plans to create a competitive USAF-wide challenge event. Maj. Gen. Clifton D. Wright, Jr., who served as Director of Engineering and Services, supported the idea and endorsed the plan in 1985. The event was designated Readiness Challenge. An award for overall challenge winner was established and named the Meredith Trophy, paying tribute to Brig. Gen. William T. Meredith.[546]

The first Readiness Challenge took place in June 1986 at Eglin AFB, Florida. Teams of 25 personnel from 11 commands participated in seven competitions. The challenge utilized multiple personnel in a simulated warzone; their mission was to build a base in the hot Florida sun. Activities were divided among teams, with each team evaluated separately. The five-day challenge included RRR, revetment erection, and general construction. Teams were not brought together randomly; they were required to include personnel with prescribed specialty codes. The challenge tested the ability to construct quickly, efficiently, and safely while also examining teamwork and operations during simulated chemical warfare. The Air Force Logistics Command's 2750th CES from Wright-Patterson AFB won the challenge. The benefits of Readiness Challenge 1986 were immediately recognized and similar future challenges were proposed.[547]

Members of a Prime RIBS team assemble a mobile kitchen trailer for use during Readiness Challenge at Eglin AFB, Florida.

Brig. Gen. William T. Meredith (Ret.) presents the Meredith Trophy to the Air Force Logistics Command team, the overall winners of Readiness Challenge '86.

Unlike the first challenge, Readiness Challenge '87 included services and fire protection personnel. The number of competitions rose to 25. Teams of 20 incorporated 12 engineers, 5 services personnel, and 3 fire protection personnel. The Air Force Systems Command's 3202d CES and 3201st SVS from Eglin AFB along with the 5610th CES from Edwards AFB won the challenge.[548]

In 1989, Readiness Challenge III included 14 teams and 22 competitions. The "Fog-of-War" was introduced at this challenge. The Fog-of-War placed teams in wartime scenarios and simulated environments to test their capabilities; this particular event became one of the most demanding yet useful events in future Readiness Challenges. TAC's 354th CES from Myrtle Beach AFB and the 325th SVS from Tyndall AFB won the overall challenge and received the Meredith Trophy.[549]

Readiness Challenge '90 was not held due to activities associated with Operation Desert Shield. The next Readiness Challenge was initially planned for 1992, but was rescheduled as a result of Hurricane Andrew. It was eventually held in 1993 and was the last Readiness Challenge at Eglin AFB before the relocation to Tyndall AFB.[550]

Deployments

Bright Star

In 1979, the 819th RED HORSE Civil Engineering Squadron moved to Royal Air Force (RAF) Wethersfield in England to provide assistance with RRR. The goal of the assignment was to support NATO responsibilities in light of a potential threat to the Warsaw Pact. The unusual assignment was unlike previous rapid assignments to support bare base operations. The RED HORSE squadron was divided into six groups, each assigned to a separate main operating base. Each group consisted of 39 RED HORSE personnel that were assisted by 52 personnel provided by the operating base. Training facilities established at RAF Wethersfield provided experience in RRR, educating approximately 600 personnel within only a four month period. In addition, personnel with RED HORSE educated

RAF food service personnel on how to prepare meals and operate in a Bare Base situation with only mobile equipment to provide water and electricity. The 819th stayed in England until its inactivation in August of 1990.[551]

In 1981, the first-ever Exercise Bright Star required the 819th RED HORSE Civil Engineering Squadron stationed at RAF Wethersfield to prove its ability to rapidly deploy and to successfully complete a bare base mission. In November, the 25 personnel of the 819th were transferred through RAF Mildenhall to Camp Darby in Italy and eventually departed for Southwest Asia from the Pisa, Italy airport. They carried 66,000 pounds of equipment and supplies, including Harvest Eagle kits, in a C-141B. Their destination was the Sudan, where they were expected to support the Joint Unconventional Warfare Task Force by establishing a tent city and organizing and operating a field kitchen. Upon arrival on Thanksgiving Day, the squadron members found themselves surrounded by desert land. The one deserted building at the site was turned into a kitchen within hours and was used to prepare a hot Thanksgiving meal the same day. Creation of a tent city also began immediately; by the end of the day, tent locations were established and eight were assembled.[552]

During the following days, bathrooms and additional facilities were constructed by joint services including Army, Navy, Marines, and Air Force. Initially the Air Force was responsible for monitoring and treating water for the site. Eventually, the site was given access to a nearby water supply. Once a water treatment facility was created by the Army, the USAF civil engineers assisted with maintenance and ensured operability. The field kitchens were put to the test in the hot environment, but their requirement to provide meals for approximately 550 personnel was met. An unanticipated exercise involved Sudanese troops. Air Force civil engineers were asked by the Sudan Engineering Corps to provide training for 18 Sudanese military personnel who needed to learn operational and maintenance skills for using ditch digging equipment acquired from America. The necessary skills were gained in only two days. Other activities during the exercise included the daily operation of the site. This was no easy task considering the desert environment. Personnel were on constant call for repairs to generators, refrigeration devices, and other equipment necessary for day-to-day functions.[553]

The 819th kitchen crew held a barbeque celebration for all 550 personnel on-site as a close to the three-week long Exercise Bright Star 1982. Tent city was dismantled, along with the field kitchen and other support facilities. The 819th proved its dedication and its vast amount of skills. The exercise was another RED HORSE success.[554]

Proud Phantom

Proud Phantom was a combined U.S. Air Force and Egyptian Air Force training exercise at Cairo West Airport. A USAF squadron flying 12 F-4 aircraft traveled to Egypt from Moody AFB in Georgia as part of the exercise. Proud Phantom provided training in deployment and bare base set-up in a desert setting. This was the first squadron to deploy and operate using Harvest Bare assets. USAF civil engineers were part of an advance echelon (ADVON) which deployed in May 1980. One of their responsibilities was to evaluate the training site in Egypt and organize future deployments for the exercise. When ADVON teams arrived at the designated site, they discovered an area with no available electrical, housing, or support facilities. One week later, 95 personnel from the 823d Civil Engineering Squadron (RED HORSE) located at Eglin AFB arrived at the training area to assist in readying the site.[555]

Only a few days later, the 4449th Mobility Support Squadron from Holloman AFB reached the training site, with 45 personnel. The 4449th immediately began erecting temporary buildings. ADVON personnel resided in a tent city while completing preparations of the site. By June, Harvest Eagle kitchens were in place, allowing hot meals to be prepared for all personnel. Within only weeks, 500 personnel were located at the site, which was quickly turning into a full-fledged installation.[556]

A 1981 article published in *Engineering & Services Quarterly* expands upon the extent of their first missions:

> They first established a 3,000 kW power plant with a ten-mile distribution system and then erected 64 personnel shelters, 29 maintenance shops, 21 offices, eight warehouses, an aircraft hangar, five latrine facilities, three shower facilities, a dining hall, field laundry, tactical site exchange, chapel and a medical clinic.[557]

In addition, "they layed [sic] 18,000 square feet of AM-2 matting for aircraft parking and installed a 1,500 gallon-per-hour water purification system with over 2 ½ miles of water distribution lines."[558]

On July 10, the 12 F-4s arrived at the site. Prime RIBS personnel were assigned the responsibility of preparing hot meals beginning in July; they continued the service everyday through October, providing four hot meals a day. They battled equipment malfunctions commonly caused by the harsh environment, but proved themselves capable of coping in a difficult situation.[559]

The USAF and Egyptian Air Force personnel worked together on many projects as part of combined training. They joined to complete apron repairs, remove sand dunes, and ensure water services. Proud Phantom began wrapping up in September. Teams made up of the 4449th Mobility Squadron and the 823d RED HORSE completed clean-up of the site during the month of October. The base was completely dismantled in 16 days, and troops left no trace of its existence. Once the Harvest Bare equipment was packed for deployment back to the US, the Egyptian Air Force personnel illustrated their continued support by ensuring that hot water was available for C rations for the U.S. troops.[560]

Team Spirit

Team Spirit was the name of an annual exercise that occurred in South Korea between 1976 and 1993. The Army, Navy, Marines, Air Force, and Republic of Korea forces were all involved. The exercise began in order to strengthen the working relationship between U.S. and Republic of Korea forces and also to ensure that the two could work together as a team if defense of South Korea became an issue. Eventually, Team Spirit exercises also involved Air Reserve Forces. Prime BEEF, Prime RIBS, and RED HORSE also participated. Each Team Spirit exercise built upon the activities of the previous year's exercise, which allowed problems to be addressed. In addition, each year resulted in an after action report. Planning for the annual exercise was complex and required detailed coordination.[561] A discussion of the 1981 Team Spirit exercise provides an example of the amount of materials and planning needed to successfully stage the event:

> numerous forces had to be identified and notified, CONUS Air Reserve Force volunteers located, time-phasing of the forces established and airlift arranged, orders cut, tent city materials ordered, war readiness materials (WRM) vehicles requested, rations ordered, Harvest Eagle and WRM assets identified…the most critical aspect was to insure all materials, equipment, vehicles, and personnel arrived at the appropriate place at the appropriate time in order to insure the bases were ready when the first aircraft and support personnel started to arrive.[562]

Participants in the 1981 exercise included 61,500 U.S. and 110,000 ROK troops. Korean engineers along with Army engineers and RED HORSE personnel organized the site and readied it for operations. Tent cities were constructed, the U.S. Army provided field kitchens and a multitude of additional support facilities were erected and maintained. U.S. Air Force personnel included Prime BEEF teams, RED HORSE, BCEs, Prime RIBS, ANG, and Air Force Reserves. At the close of Team Spirit 81, participants had "provided conclusive proof that [they] can meet the challenges of contingency operations by using teamwork and more appropriately, 'Team Spirit.'"[563] The Team Spirit exercise ended in 1993 to avoid friction between North and South Korea.[564]

Civic Action Programs and Disaster Response

Civil engineers and Services personnel have specialized skills critical for military deployment, which require continual training for mission readiness. These skills are equally valuable to both the military and civilian community during emergencies or during the recovery from natural disasters. When natural disasters affect an Air Force base's operations, the base civil engineering organization often implements its base recovery plan.

Civic Action Programs

Air Force engineers continued to participate in United States military's Civic Action Program by deploying Civic Action Teams (CAT). Beginning in 1970, CATs were sent yearly to the Trust Territories of the Pacific Islands to assist in economic development in that region.[565] Under the direction of the U.S. Navy, CAT 81-09 deployed to the Truk Islands from September 1981 to April 1982. The group comprised thirteen Air Force civil engineer members, including "a Civil Engineer, NCOIC in Heavy Equipment, five equipment operators, three mechanics, one medic, one radio operator/electrician, and one vertical construction specialist." The CAT's mission was to build a 1.1 mile access road to a water well and to erect a pre-engineered Butler building measuring 20 x 48 feet at the CAT camp to be used as a workshop/recreation area. Road construction proved to be more difficult due to soil conditions, rugged terrain, and the continual rain. In addition to the two assigned missions, the CAT completed 35 additional local jobs for the community. Team members not only worked in their own specialty, but also performed tasks outside their specialty. The CAT provided benefits both to team members and to the local community. The team members performed under challenging conditions. The local community received benefits from the construction projects and also received training in equipment operation and mechanical skills. When the mission was complete, the members of CAT 81-09 were given honorary Trukese citizenship, a singular honor for this CAT.[566]

Disaster Response

Prime BEEF and Prime RIBS personnel offered ready-made teams for mission deployments either through intra-command or inter-command assignment. While major commands controlled intra-command deployments of less than 90 days, all inter-command assistance was requested through the Directorate of Readiness AFESC. Inter-command deployments were three types: "MAJCOM-sponsored exercises or Headquarters U.S. Air Force Contingency Support Staff-directed operations; inter-command emergency assistance or disaster recovery; and, support of special project requirements."[567]

On the local level, Air National Guard personnel often assisted in community construction projects in their respective states, as well as mobilized in times of natural disasters. By participating in these kinds of activities, civil engineers and services personnel maintained their ability to mobilize and applied their training to aid and assist others, while gaining real world, hands-on, project-oriented experiences. When training dovetailed with application and community service, it was a win-win situation for all participants. Air Force engineers have a proud history of supporting local communities and the Air Force in these efforts.[568]

In May 1976, civil engineers from the 40th Civil Engineer Squadron stationed at Aviano Air Base, Italy, were deployed to the nearby village of Forgaria to help the community recover from an earthquake. The earthquake destroyed approximately 50 percent of Forgaria. Engineers with earth-moving equipment assisted the local community in recovery operations. For a period of 30 days, approximately

100 engineers removed huge boulders and landslides to open up roadways, carted away building debris, and cleared clogged storm drainage systems.[569]

In 1979, McConnell Air Force Base and the surrounding areas of Kansas were struck by an ice storm along with blizzards and below zero temperatures. The base lost commercial power for 19 hours; the severe cold, snow and ice conditions, and high winds precluded rapid repair of the electric lines. Six hundred family housing units, as well as hundreds of unaccompanied personnel in dormitories, were without heat. The base activated its base recovery plan, which included "initiate full squadron recall, establish damage control center, provide standby power to ten key facilities," and "initiate preventive measures against boilers, water lines and sprinkler system freezing." Once the commercial electric power was restored and the heat turned on, the initial emergency was over. After the water system pipes thawed, the number of plumbing repairs from broken and leaking pipes and fixtures was staggering. Adopting the structural maintenance and repair team (SMART) concept, teams comprising a plumber, an electrician, a mason, a painter, and two carpenters were assigned to specific areas of the base. Their priorities were to fix living quarters, living areas, operational areas, service areas, and finally general repairs. Within two weeks, approximately 99 percent of the repairs were complete. The base also assisted Kansas Gas and Electric Company in repair efforts.[570]

Hurricane Frederic slammed into the Gulf Coast in September 1979, doing extensive damage to Alabama and Mississippi. Keesler AFB, Mississippi, suffered significant damage from the estimated 100 mile per hour winds. Prime BEEF teams from five bases responded with carpenters, exterior electricians, and equipment operators. The 823d RED HORSE Squadron deployed from Hurlburt Field, Florida, to assist in the cleanup. Combined with Keesler's civil engineers, the deployed personnel helped restore the base's training mission in only four days.[571]

When Mt. St. Helens in Washington erupted in May 1980, Fairchild AFB located approximately 250 miles southwest of the mountain was covered in ¾-inch of ash. This ash resembled extremely abrasive talcum powder. The ash, when analyzed, comprised 60 percent silicone and 16 percent aluminum. The weight of the ash measured 65 pounds per cubic foot dry and 100 pounds per cubic foot wet. Removal of the ash presented a challenge. On-the-site research was conducted to determine the best method for removal. High pressure water washing with detergent was the best method. The ash also infiltrated water disposal systems and mechanical systems throughout the facilities on the base. In all, the base civil engineer squadron devoted 27,000 hours to removing the ash.[572]

In April 1980, Eglin AFB, Florida, was selected as the site for a processing center for Cuban refugees. Initially planned to accommodate 1,000 persons, the estimated numbers of refugees rose to 10,000. On June 30, 1980, the center housed 2,000 Cuban refugees. Extensive efforts by Prime BEEF, RED HORSE, and Prime RIBS units, including reservists, were required to construct and to operate the refugee camp.[573] In May 1980, eight reservists were deployed to the camp to assist in food service operations.[574]

During 1982, several civil engineering units assisted in tornado cleanup. Forty-three members from the 375th Civil Engineering Squadron stationed at Scott AFB, Illinois, traveled to Altus AFB in Oklahoma to provide assistance following a tornado at the base. In December 1982, a tornado swept through Scott AFB, Illinois, and caused damage to the surrounding community of New Baden where many military families lived. Air Force engineering volunteers initially assisted in keeping power generators operating. Reservists from the 932d Civil Engineering Squadron were among 100 reservists that assisted in the cleanup operations and provided medical support. The 932d CES commander reported, "The cleanup of New Baden was similar to the wartime mission for which this unit is trained —repairing bombed runways and facilities after an attack…. [Though] It would have taken an awful lot of bombs to do that much damage."[575]

In April, members of the Prime BEEF team at Carswell AFB, Texas, assisted the local community of Paris to recover from tornado damage. Supporting local response operations provided valuable lessons for civil engineer units in dealing with other Federal agencies like the Federal Emergency

Management Agency (FEMA) and Non-Government Organizations like the Red Cross. Second Lt. Marvin Fisher (later Col.) was the Carswell Chief of the Readiness and Logistics Division, when the Carswell AFB team deployed to Paris, Texas, and recalled his first interaction with FEMA officials,

> Captain Tom Gross and I were called down to the local FEMA Director on the second day of our arrival thinking he was going to welcome our support. Surprisedly, he was furious that the DoD had showed up at his disaster scene without his knowledge. When he asked did we know he was personally appointed by President Reagan himself I thought for sure we were in big trouble and I was going to go home an airman basic. Luckily, Captain Gross was calm and collected about it, and explained that we had cleared our deployment through Strategic Air Command officials and coordinated with the Red Cross, and we left the meeting in good standing. But I learned the valuable lesson to always clear training deployments with higher headquarters.[576]

On September 22, 1989, Hurricane Hugo struck South Carolina and damaged both Charleston and Shaw Air Force Bases. Based on initial damage assessment, base civil engineers called for assistance from RED HORSE units to help clean up the debris and to restore basic utility functions. Engineers with the Military Airlift Command from Little Rock, Arkansas; Hurlburt Field, Florida; and Pope AFB, North Carolina, were deployed to Charleston AFB. CEMIRT technicians from Dover AFB, Delaware, delivered two 1 megawatt generators and two 250 kilowatt generators.[577] Tactical Air Command deployed engineers, along with their heavy equipment, from the 823d RED HORSE squadron at Hurlburt Field, Florida, to Shaw AFB. The 823d RED HORSE responded to the call for assistance by mobilizing over 180 persons. Twenty-eight plumbers, electricians, and power production personnel were sent to Shaw AFB by commercial airplanes, while another 130 personnel convoyed with their heavy equipment to the area. The convoy reached Shaw AFB 55 hours after being tasked. The two primary jobs performed by the 823d RED HORSE during its 19 days of deployment were to remove fallen trees in the family housing areas and in base operations areas and to repair roofs in the family housing areas. Crews removed fallen trees from buildings and roadways and the airfield. Other team members made repairs to roofs of 600 family housing units, as well as to base operations buildings. Electricians worked to restore base power, while other members completed damage assessments for 250 facilities. Deployed food services personnel augmented the base's dining hall staff to feed hundreds of base residents and relief workers. Food services personnel also set up a Mobile Kitchen Trailer and a mess tent to serve thousands of meals to the local residents from nearby communities.[578]

After the initial emergency response to the hurricane-damage, Air Force civil engineers were requested to assist the wider community around Charleston, South Carolina. Working with several local governments and the Federal Emergency Management Agency, staff from Headquarters, AFESC surveyed damage in the area and identified projects that would both assist the community and provide realistic training to Prime BEEF and RED HORSE teams deployed for two-week periods. Deployments began by February and continued through August 1990. A 50-person Prime BEEF team from the 47th Civil Engineering Squadron, Laughlin Air Force Base, Texas, worked to repair the Charleston Memorial Hospital, the Palmetto Pathways Home, and the Horizon House. A 50-person Prime BEEF team from 384th CES from McConnell AFB, Kansas, repaired a water pumping facility, worked on preserving sand dunes, and relocated an access road. A 50-person team from the 307th RED HORSE Squadron (AFRES) from Kelly AFB, Texas, repaired youth recreation facilities in North Charleston.[579] When the final deployment occurred in August 1990, Air Force personnel had contributed over 6,800 man days to clean-up and repair activities in communities in and around Charleston. In all, nine civil engineering teams comprising Prime BEEF and RED HORSE members participated in the Hugo clean-up efforts. Civil engineering squadrons that participated included the 47th CES, Laughlin AFB,

Civil Engineers assist in the clean up following Hurricane Hugo.

Texas; 384th CES, McConnell AFB, Kansas; 307th RED HORSE CES (AFRES), Kelly AFB, Texas and Barksdale AFB, Louisiana; 103th CES, Peterson AFB, Colorado; 2852th CES, McClellan AFB, California; 2854th CES, Tinker AFB, Oklahoma; 3245th CES, Hanscom AFB, Massachusetts; 179th CES (Air National Guard), Mansfield, Ohio; and, the 440th CES (AFRES), Milwaukee, Wisconsin. In addition to the repair teams, seven Air Force Reserve engineers and technicians worked 58 days to provide technical design review and engineering analysis.[580]

THE END OF THE COLD WAR

By the end of the 1980s, the military geopolitical climate was reshaped dramatically. Mikhail Gorbachev was chosen as leader of the U.S.S.R. in 1985 and set into motion events that had far-reaching effects. Within a month of assuming leadership, Gorbachev announced a moratorium on the deployment of new intermediate-range nuclear missiles. Gorbachev also set out to reform the economic and political structures of the U.S.S.R. He called for political and economic reform of the U.S.S.R system under *perestroika*. In addition, Gorbachev opened politics to public debate and criticism under *glasnost*. Gorbachev formed a close personal relationship with U.S. President Ronald Reagan and engaged in a dialogue resulting in the negotiation of the Intermediate-range Nuclear Forces treaty. This treaty was signed by Reagan and Gorbachev on December 8, 1987. The treaty required the verified destruction of 2,611 U.S. and Soviet nuclear warheads. Gorbachev also reduced military spending and removed Soviet troops from Afghanistan, ending their participation in the guerilla war.[581]

Gorbachev's calls for reform resonated throughout the Warsaw Pact countries, particularly after the U.S.S.R. announced its intent to allow self-determination. Most of those countries responded by transitioning from the communist political system to more democratic governments. The German Democratic Republic (East Germany) ignored the growing popular support for self-determination during 1988 and through most of 1989. When the barbed-wire fences between Hungary and Austria were removed in May 1989, East German citizens traveling on vacation documents crossed through Hungary to the West. Peaceful demonstrations against the East German government increased in number during the fall. With mounting pressure for change, the East German cabinet resigned on November 7, 1989. The infamous Berlin Wall, which had divided the city since 1961, was permanently breached on November 9, 1989. The two Germanys moved closer to reunification in 1990. Germany was reunited formally at one minute after midnight on October 3, 1990.[582]

The U.S.S.R. had been the major United States adversary during the Cold War. World tensions had been held at bay by the arms race and political brinkmanship. The U.S. military played a central role in defusing Soviet aggression through strengthening the American defensive posture.

When Maj. Gen. Joseph A. Ahearn became Director of Engineering and Services in February 1989, the effects of these geopolitical events were already being felt throughout DoD and the Engineering and Services Directorate. Military planners already were experiencing decreasing budgets between 1987 and 1989.[583] The U.S. Congress was mandating personnel reductions.[584] Base closures under BRAC were being implemented and a DoD-mandated Defense Management Review to reduce the DoD budget by $30 billion over five years was underway.[585]

In addition, General Ahearn was at the helm of Engineering and Services when the Berlin Wall fell. When asked what that was like, he recalled,

> Well, the first thing they needed to do was to clean up their hangover. That was quite a celebration. But we could immediately see the restructuring and the downsizing of the armed forces. Then there was the question about the need for so much investment in the forward basing network of NATO. It came down to operational experience and real need for preparedness for armed conflict. There's no better place for learning that than in the theaters where the operations are occurring, so the USAFE and Middle East assignments continue to be of great value…We had drawn down greatly in Asia, in the Pacific theater. We don't have many bases out there. We've been drawn down by the Congress. Why are we spending so many resources over there? There was a national debate going on about what do we owe Europe, and why have we got such an enormous security investment over there? We got engaged in that big-time after the Wall came down.[586]

General Ahearn expressed pride in the Engineering and Services organization that he led at the end of the 1980s:

> the civil engineering business, including the environment movement, had achieved real respect and real pride. Wing commanders wanted civil engineer leaders at their right side. If you had that kind of support, then you'd better have a darned good program to complement the command emphasis and the command support. That was the spirit of the whole environmental program. The Congress was investing in us. Bob Stone, the leader of the installations business at OSD, was watching us, because doctrinally our mission was to put into place high-quality infrastructure and high-quality facilities, to make operations more effective and more efficient. Said another way, you can buy extra wings of airplanes ready to fly with operational cost savings, if your people are proud and productive. We were about making that happen through these kinds of programs…I remember the ragtag bunch of guys we were in 1958. I must tell you, we're really different today. And we're an active part of the Air Force mission today, not just a bunch of support grunts.[587]

A successful Air Force civil engineer of the future, General Ahearn counseled, not only required professionalism in the civil engineering field and professional management skills; he should also be a student of geopolitics and their impacts on Air Force missions. He must also be adaptable to change. [588]

CHAPTER 5

RESPONDING TO NEW CHALLENGES 1991-2000

INTRODUCTION

During the 1990s, following the end of the Cold War, civilian and military leaders turned their attention to redefining the role of the U.S. military, including the U.S. Air Force. The geopolitical landscape was changed dramatically with the demise of the U.S.S.R. The singular threat of communist expansion was replaced by numerous potential threats to U.S. interests from the economically and politically fragmented former Soviet Bloc countries or the former Yugoslavia. These threats necessitated a possible military response focused on a single opponent or intervention in regional conflicts.[1]

In June 1990, Secretary of the Air Force Donald B. Rice (1989-1993) published a white paper entitled "Global Reach - Global Power." In this paper, Rice redefined the Air Force contribution to national security as providing aerospace power capability to deliver precise and flexible applications of national power to complete missions anywhere in the world in hours rather than days. The speed and range of jet aircraft, increased precision of weapons guided by space-based navigation and communication equipment, and military flexibility supported the Air Force in meeting this mandate.[2]

The concept of Global Reach - Global Power was integrated into the defense strategy announced by President George H.W. Bush on August 2, 1990. The major shift in military strategy was accompanied by a proposed 25 percent reduction of military organizations and personnel, as well as dramatically decreased defense budgets adopted in November 1990.

On August 2, 1990, Iraq invaded Kuwait triggering Operation DESERT SHIELD on August 7, 1990 and Operation DESERT STORM between January 17 and February 28, 1991. These intense international efforts refocused U.S. military preparedness toward involvement in regional conflicts rather than the previously anticipated large-scale war scenarios between major world powers. During both operations, Air Force civil engineers executed beddown, sustainment, and mission support assignments in an international environment with a high level of efficiency and professionalism that was recognized by all U.S. Armed Services. The lessons learned from deploying during the Gulf War were incorporated at all levels of the Air Force civil engineer organization. This experience shaped and reshaped civil engineer readiness requirements, doctrine, and training during the 1990s.

The National Military Strategy issued in 1992 identified four primary elements: strategic nuclear deterrence and defense, forward presence, crisis response, and reconstitution. The strategy recognized new global challenges and assumed that U.S. military forces would be deployed, not in a single major war, but in up to two simultaneous major regional contingencies. Additional force drawdowns also were implemented in accordance with arms reduction talks and the ratification of a series of Strategic Arms Reduction treaties between the United States and the U.S.S.R., which became the Russian Federation in 1991. When President William Clinton took office in 1993, defense reductions continued following a "Bottom-Up Review." Additional reductions were made possible by modifying the defense strategy to assume force deployments in up to two "nearly simultaneous" regional contingencies.[3]

By 1992, the concept of Global Reach-Global Power evolved to incorporate five principles. As Secretary Rice wrote: "The principles outlined below enable the Air Force to deliver the watchful eye, helping hand, or clenched fist that the situation may demand and which the nation has come to expect."[4] The five principles were "sustain deterrence, provide versatile combat capability, supply rapid global mobility, control the high ground, and build U.S. influence."[5] These principles informed planning decisions that transformed the Air Force civil engineer organization into a smaller, leaner force capable of meeting unpredictable threats and executing new missions in a changing geo-political world climate.[6]

The Air Force responded to the new international and U.S. political realities of the early 1990s through a far reaching reorganization. Air Force Chief of Staff, Gen. Merrill A. McPeak initiated reforms that dramatically reshaped the entire Air Force, including Air Force Civil Engineering. General McPeak instituted the concept of a "total quality Air Force" and conducted an intense review of the Air Force's vision, missions, and organizational structure. Each area of the Air Force was tasked to review its core values, basic principles, and operating style to achieve the ideal of quality, which was defined as "leadership commitment and operating style that inspires trust, teamwork, and continuous improvement everywhere in the Air Force."[7]

On September 17, 1991, the most sweeping restructuring of the Air Force since 1947 was announced. The restructuring was designed to reflect the vision of Global Reach - Global Power, to build up combat capability, and to incorporate modern management practices and principles by strengthening the command chains, decentralizing large headquarters organizations, consolidating resources under a single field commander, streamlining organizational structures, and clarifying functional responsibilities. On the Pentagon level, the Air Force Headquarters staff, including the Air Force Civil Engineer's Office, was reduced by 21 percent to a total of 2,565 personnel.[8]

On the major command level, General McPeak reorganized the 13 Air Force Commands into 10 commands. Elements from the Strategic Air Command (SAC), the Tactical Air Command (TAC), and Military Airlift Command (MAC) were consolidated into two commands, the Air Combat Command (ACC) and the Air Mobility Command (AMC). The formal inactivation of SAC, TAC, and MAC, and the institution of ACC and AMC occurred on June 1, 1992. On the same day, the Department of Defense (DoD) established the U.S. Strategic Command charged with planning, targeting, and commanding DoD-wide strategic forces. Air Force Systems Command and the Air Force Logistics Command were merged into the Air Force Materiel Command (AFMC) on July 1, 1992. Air University and Air Training Command were combined to form Air Education and Training Command on July 1, 1993. On that same day, control of the ICBMs was transferred to the Air Force Space Command (AFSPC). AFSPC, Air Force Special Operations Command, Pacific Air Forces (PACAF), and U.S. Air Forces in Europe (USAFE) were retained with reduced personnel and decreased numbers of main operating bases.[9]

By the mid-1990s, the Air Force was primarily based in the continental United States (CONUS) with a limited forward presence on a few bases in Europe and in the Pacific. By 1996, the Air Force shrank from a blue suit force of 610,000 persons to 400,000; civilian personnel numbers also decreased from 252,000 to 166,000 in FY99.[10] While fewer in numbers, Air Force civil engineers supported an expanding number of short-notice deployments for peacetime assignments, as well as a greater number of military operations other than war (MOOTW).[11] These latter operations included support for combat operations, such as enforcing sanctions and exclusion zones, and non-combat missions, such as peacekeeping missions, recovery operations, humanitarian missions, and nation assistance.[12] Air Force civil engineers were deployed to support the U.S. Air Force mission in Southwest Asia (SWA), Somalia, Haiti, Bosnia, Kosovo, and in Central and Latin American countries.

During the late 1990s, the U.S. Air Force issued a new vision for air power designed to carry the organization into the new millennium. Entitled *Global Engagement: A Vision for the 21st Century Air Force*, the document was predicated on provisions of the revised National Defense Strategy that required the U.S. Air Force "to rapidly defeat initial enemy advances short of their objectives in two theaters in close succession."[13] The Air Force identified the core competencies of rapid global mobility, precision engagement, global attack, air and space superiority, information superiority, and agile combat support as critical to maintaining air and space superiority. The Air Force civil engineering community began to define its role, doctrine, and readiness training to support new concepts, such as the Air Expeditionary Force and agile combat support.[14]

By 1997, the Air Force total personnel strength was approximately 731,000, including military and civilians. Approximately 8.2 percent, or 62,000, were assigned to the Air Force civil engineering organization. Of that number, 34,000 were military.[15] By the close of the 1990s, Air Force Civil

Engineering had weathered major reorganizations. The organization undertook increasingly complex duties both at home stations and during deployments with a high level of competence and readiness in an environment characterized by simultaneous operations. Throughout the 1990s, civil engineer personnel performed as warriors, professionals, and ambassadors.

CIVIL ENGINEERING AIR STAFF PROGRAMS AND POLICIES

The Civil Engineers

Maj. Gen. Joseph A. "Bud" Ahearn became the Director of Engineering and Services in March 1989 and served as The Civil Engineer between February 1991 and January 1992 when it became an Assistant Chief of Staff-level position. As The Civil Engineer, General Ahearn oversaw a major restructuring of the Air Force civil engineer organization and prepared the organization to face massive personnel and budget reductions. General Ahearn redefined the civil engineers' core vision, supported continuing civil engineer readiness programs, implemented the concept of Total Quality Management through all levels of the civil engineer organizational structure, and was instrumental in reshaping the Air Force Engineering and Services Center (AFESC). General Ahearn headed the organization through Operations Desert Shield and Desert Storm. He directed the development of a separate civil engineering combat support doctrine, which was published in 1991. He ensured a firm foundation for the Air Force environmental program through incorporating environmental awareness into all aspects of civil engineering, oversaw the formation and establishment of the Air Force Center for Environmental Excellence (AFCEE), and supported quality of life programs for Air Force personnel. General Ahearn also was a champion for the enlisted force and for the chief master sergeants. He was only the fourth person to receive the Air Force Order of the Sword, the highest honor that the enlisted force can bestow.[16] In his honor, the Maj. Gen. Joseph A. Ahearn Enlisted Leadership Award was established to recognize the civil engineering chief master sergeant who displays the most exemplary leadership qualities.[17]

Mr. Gary S. Flora

Maj. Gen. James E. McCarthy

General McPeak chose Mr. Gary S. Flora, then the Associate Civil Engineer and a member of the civilian Senior Executive Service, to serve as The Civil Engineer between February and October 1992.[18] He was the only civilian to serve in this position and was the logical choice because he had served previously in civil engineer assignments at base, major command (MAJCOM), Air Force Regional Civil Engineer (AFRCE), Air Staff, and in the Engineering and Services Directorate since 1985. Mr. Flora assumed the position with the knowledge that the Assistant Civil Engineer, then Brig. Gen. James E. McCarthy, was in line to become The Civil Engineer, but his promotion to major general was held up by a Congressional investigation. When the investigation was resolved, General McCarthy became The Civil Engineer in October 1992.[19] Mr. Flora was well-versed on major projects, programming processes, and wartime engineering. As The Civil Engineer, Mr. Flora presided over the 1992 implementation of the Air Force major command reorganizations, and dealt with continued pressure to draw down civil engineer manpower resulting from the adoption of the objective squadron model. Mr. Flora characterized his time as The Civil Engineer as a team effort with General McCarthy. In November 1992, Mr. Flora resumed his position as Associate Civil Engineer where he served until his retirement in 1994.[20]

Maj. Gen. James E. McCarthy served as The Civil Engineer between October 1992 and July 1995. General McCarthy became The Civil Engineer at the rank of brigadier general and was promoted to major general on July 1, 1993. The position of Assistant Civil Engineer was discontinued when he moved up to become The Civil Engineer. His successor would come from a major command, not the Air Staff. General McCarthy focused on organizing, equipping and training the civil engineer work force to be more effective in dealing with new missions and the directed manpower reductions associated with the "objective wing concept." He also continued to implement the Total Quality Management concept throughout the career field. He also pursued an aggressive environmental program throughout the Air Force. He advanced the incorporation of environmental stewardship into the development and acquisition phases of future weapon systems, as well as into the operational tempo of the Air Force by mainstreaming the environmental program. His goal was to eventually have *no* environmental staff:

Maj. Gen. Eugene A. Lupia

"When environmental matters are totally integrated into the culture and fabric of the Air Force, there will be no need of dedicated environmental staff," General McCarthy said.[21]

As The Civil Engineer, General McCarthy's priorities were "to improve the readiness and training of the civil engineer force, boost environmental performance, improve the availability and quality of housing, and protect the resource base of civil engineer programs from reductions at the Air Staff and at the Office of the Secretary of Defense." He oversaw the implementation of the civil engineer objective squadron. Because The Civil Engineer had a seat on the Air Force Council and reported directly to the Chief of Staff during this time, General McCarthy was able to make measurable progress in achieving his priorities, including implementing a new dormitory standard that provided single rooms for all Airmen. Another program that bore fruit during his tenure was video- and computer-based training and testing, spearheaded largely by the fire protection community, the adoption of multi-skilling for the base civil engineer squadrons, and providing entry-level technical training for every Airman.[22]

Maj. Gen. Eugene A. Lupia served as The Civil Engineer between July 1995 and July 1999. General Lupia came to the job directly from the position of Civil Engineer at Headquarters AMC. He was the first graduate of the U.S. Air Force Academy to become The Civil Engineer. Although he transferred directly from a major command, he was no stranger to the Pentagon. While a captain during the 1970s, General Lupia had served as the executive officer and in "the front office" under four directors.[23] He was a team builder who strengthened the relationships among the Air Force civil engineer organization and the Office of the Secretary of Defense (OSD), the Air Staff, other branches of the U.S. Armed Forces, and the major commands. In 1996, General Lupia formed the Airmen's Council to operate in conjunction with the Chiefs' Council to "identify and fix Airmen problems."[24] Both councils were organized under the leadership of CMSgt. Kenneth Miller, General Lupia's Chief of Enlisted Matters. The Chief's Council purpose was to "identify, discuss, and recommend solutions to the major squadron concerns."[25] In 1998, CMSgt Miller also worked to establish an exchange program for senior noncommissioned officers (NCOs) between two RED HORSE squadrons and two Navy Seabee units to gain insight, knowledge, and perspective in preparation for future joint deployments. This was the Air Force's first NCO exchange program.[26]

Maj. Gen. Earnest O. Robbins II

General Lupia continued the work to upgrade dormitories and to implement other quality of life initiatives. He was proud of the Dormitory Master Plan, which evaluated all Air Force dormitories to program funds for renovation. Under his leadership, the civil engineer organization began a concerted effort to outsource non-essential military functions and to privatize military family housing and utilities. Outsourcing and privatization were partially the result of a major civilian reduction in force. General Lupia and his staff worked to quantify the number of military personnel required to fight two major theater wars and to preserve and maintain the readiness core. That number identified was 28,401 personnel and included active, Air Force Reserve, and Air National Guard members. General Lupia was involved in the OSD efforts to expand the environmental programs internationally. He worked on environmental cleanup issues with Air Force counterparts in Russia and Italy.[27] When General Lupia retired, the annual awards for Outstanding Civil Engineer Company Grade Officer, NCO, and Airman were named in his honor.

Maj. Gen. Earnest O. Robbins II became The Civil Engineer in July 1999 and served until May 2003. He transferred to the position directly from the Civil Engineer position at Headquarters ACC. He oversaw the Air Force civil engineer organization into the first decade of the 21st century. While at ACC, General Robbins reviewed the RED HORSE units to determine if those units were "relevant, right-sized, and ready" for deployment. He proposed similar reviews for the entire civil engineer community to ensure that civil engineers continued to support the mission of the Air Force. General Robbins foresaw ongoing emphasis on privatization and outsourcing base civil engineering functions due to declining budgets and personnel constraints. He supported expanding quality of life initiatives to include the military workplace in addition to dormitories and family housing. He also was involved in the early implementation of the Expeditionary Aerospace Force (EAF).[28]

Civil Engineering Structural Reorganizations

During the 1990s, the Air Force civil engineer organization underwent several major restructurings. Dramatic changes occurred in the first half of the decade because of intense pressure to reduce manpower and budgets. The vision of "Global Reach - Global Power" as proposed by Secretary Rice was supported by the Air Force Chief of Staff Gen. Merrill A. McPeak, who was appointed on November 1, 1990. General McPeak had a radical new vision to restructure the Air Force. By the end of December 1990, General McPeak secured approval for his reforms from Secretary Rice and began to implement his vision for change. The new structure proposed for the Air Force, General McPeak explained, was appropriate whether the Air Force grew, decreased in size, or stayed static. He proposed an "objective Air Force" supported by "objective numbered air forces, objective wings, and objective squadrons." With the decreasing funding appropriations, General McPeak argued that the Air Force purposefully should control its own reorganization rather than react to budget cuts and manpower cuts imposed by the U.S. Congress.[29]

Defense Management Report Decision 967

During 1990, the OSD conducted a series of exhaustive reviews of the organizational structure of the Armed Services to identify budget and manpower savings. Under intense review were the civil engineer organizations of the Air Force, Army, and Navy. The objective of this scrutiny was to answer the question "can cost reductions and improved efficiencies be achieved through consolidations of base engineering services, reductions of excess personnel, economies of scale, improved utilization of military manpower, and reorientation of the base engineering financial and management programs to establish a business management approach to real property management?"[30] The answers were published in Defense Management Report Decision (DMRD) 967 entitled, *Base Engineering Services*, which was issued in December 1990.

Consolidation of base engineering services by establishing DoD-wide, industrially funded Public Works Centers similar to those used by the Navy was a major recommendation contained in DMRD 967. Proponents of public work centers argued that this organizational structure eliminated duplicate services and realized efficiency and economy of scale by consolidating equipment, shops, and personnel specialties. The time frame for establishing public works centers was 1992 and 1993. Additional recommendations in DMRD 967 included improving multi-year installation master plans, up-dating automated data processing, and implementing business-oriented management techniques. The cost savings through implementing DMRD 967 recommendations were estimated at $260 million in FY92 and $3 billion in the following six years through reductions in military civil engineer manpower. Reductions in Air Force civil engineer manpower were projected at 6,000 persons in FY92, followed by subsequent reductions of up to 21,795 active duty civil engineers.[31]

Secretary Donald Rice responded to DMRD 967 with a strongly-worded, three-page rebuttal. The Air Force did not concur with the recommended reductions in manpower or with recommendations for regional consolidation of civil engineering functions into public works centers. Secretary Rice requested the full restoration of manpower and funding.[32] As reported in DMRD 967, Air Force civil engineers accounted for 50 to 60 percent of military manpower on Air Force installations. While the Air Force controlled approximately one-third of all buildings and structures in the DoD real property inventory, its military manpower accounted for approximately 49 percent of military personnel in real property maintenance DoD-wide. Conversely, military personnel in civil engineering positions on Army and Navy installations typically accounted for 2 to 5 percent of base employees.[33] Secretary Rice argued that the Air Force readiness required 56,235 military civil engineers, including active and reserve personnel, to support current war plans. Existing manpower authorizations already were below the civil engineer requirement and totaled 49,951, comprising 30,571 active duty and 19,380 reserve personnel. Secretary Rice wrote:

> Air Force military engineer requirements differ from those of the Army and Navy. As Operation DESERT SHIELD has illustrated, the Air Force fights from a large network of CONUS, enroute, rear staging and forward bases. To do this, our military engineers are required to bed down weapons systems and people, operate, maintain and repair the base systems, enhance survivability, and recover bases damaged by adversaries. In contrast, the Army fights from its battlefields and the Navy from its ships. [34]

On the subject of consolidation of civil engineering functions into public works center, Secretary Rice recounted the recent "bad" Air Force experiences with the San Antonio Real Property Management Agency (SARPMA). "After trying for nearly 10 years to achieve responsive and quality installation support through SARPMA," Secretary Rice wrote, "we dissolved it in 1989 and went back to our normal support structure."[35] A discussion of SARPMA was included in DMRD 967. The defense management review team reached no clear conclusions on why SARPMA failed. It appeared to the team that SARPMA was so plagued with problems, that attributing its failure to the concept of consolidation was misplaced.[36]

Secretary Rice concluded his rebuttal to DMRD 967:

> We fully support the need to achieve maximum cost effectiveness in the base engineering support function but we do not agree that it should be done at the expense of quality and responsiveness. We firmly believe that major savings in the base engineering support function can be achieved through a substantial reduction in the base structure which the Air Force is pursing aggressively. In addition, however, we believe there is some lessor (sic) but still attractive potential for further saving through organizational streamlining and increased productivity. The Total Quality Management movement and the experience of our most successful private sector organizations clearly demonstrate that productivity increases with decentralization, not with consolidation and centralization.[37]

In November 1990, while the draft DMRD 967 was being circulated, Air Force Director of Engineering and Services Maj. Gen. Joseph A. Ahearn assembled a task force to develop alternatives to the recommendations contained in the report. The task force included 35 members drawn from the Air Staff, the Air Force Engineering and Services Center (AFESC), and the major commands. Several major command Directors of Engineering and Services served as advisors to the group. The task force examined ways to streamline management and maintenance operations on the bases, as well as strategies to retain personnel for warfighting capabilities. The findings and recommendations of the Task Force were used to support the Air Force alternative proposal to DMRD 967, which was approved by the OSD Comptroller on December 30, 1990.[38]

The alternative reduced Air Force military personnel by 6,215 and civilian personnel by 30 positions. Manpower reductions were estimated to save $602 million in personnel, salaries and benefits over the six-year Defense program. In addition to manpower reductions, the Air Force proposed restructuring base civil engineering maintenance shops by implementing the zonal maintenance organizational structure, adopting multi-skilling for enlisted craftsmen specialties, and converting unneeded military positions to civilian positions. The zonal maintenance structure required that the base shop personnel, who were organized by function, be re-assigned to maintenance shops serving distinct zones on each base. At the same time, the 17 civil engineering enlisted specialties, including carpentry, electrical, sheet metal, plumbing, etc., were reduced to 11 specialties. Craftsmen were required to learn the skill sets of other trades. Military personnel typically devoted 30 percent of their work time to military training requirements. By converting some military positions to civilian status, the Air Force proposed to increase overall workforce productivity since civilian personnel would be dedicated to their jobs 100 percent of the time. Implementation of the alternative proposal, the Air Force argued, would "reduce overhead costs, eliminate redundant layers of positions, and apply a range of Total Quality Management principles to achieve reduced costs, without reducing quality of service at all installations." The deadline for implementing the alternative was October 1, 1996, but, while the alternative was being implemented, another initiative to reorganize Air Force civil engineer organization was gaining support through the efforts of the Air Force Chief of Staff General McPeak.[39]

Reorganizations by General McPeak

General McPeak began his major reorganization of the Air Force by realigning the Headquarters U.S. Air Force at the Pentagon and reducing the number of Headquarters personnel by 21 percent.[40] Until February 1991, the Directorate of Engineering and Services at Headquarters was organizationally under the Deputy Chief of Staff, Logistics and Engineering. Maj. Gen. Joseph A. Ahearn served as the Director of Engineering and Services. Brig. Gen. James E. McCarthy served as Deputy Director and Mr. Gary Flora of the Senior Executive Service was Associate Director. The Deputy Director for Construction, the Deputy Director for Programs, and the Plans Division reported to the Director. Under the Deputy Director for Construction were the Installation Development Division and the Environmental Quality Division. Under the Deputy Director for Programs were the Programs Division, Family Housing Division, and Real Estate Division. The three Air Force Regional Civil Engineer (AFRCE) offices and AFESC also reported to the Director.[41]

Effective February 1, 1991, General Ahearn's position was elevated to Assistant Chief of Staff reporting directly to the Air Force Chief of Staff as part of a "flattening" of the Air Staff structure. General Ahearn became The Civil Engineer.[42] As General Ahearn recalled,

> Having The Civil Engineer work for the Chief of Staff, that was a McPeak call. He was playing with the wing structure and the major command structure—why wouldn't it look the same at the Air Force level? He had his Judge, he had his Surgeon, and his Civil Engineer. That's where that title came from. It wasn't the haughty sound that it looks like, "The Civil Engineer." It was the judge, the surgeon, the engineer. That's how he talked, and that's how commanders talked. That's where those titles came from. It happened to be that the Surgeon General was called The Surgeon General, and the judge was called The Staff Judge Advocate. So, he called the engineer The Civil Engineer. That was the birthright of that expression.[43]

One advantage to elevating The Civil Engineer to the level of Assistant Chief of Staff was that The Civil Engineer became a member of the Air Force Council, the senior decision-making body of the Air Force. The Civil Engineer now was able to advocate directly for Military Construction, operations and maintenance, and housing funding and personnel issues.[44]

Throughout 1991, General McPeak and the Air Staff worked to reorganize the Air Force structure from top down. General McPeak conducted a comprehensive review of all primary functional areas and sub-organizations of the Air Force. His goal was to rationalize the organization of the Air Force through a standard structure of numbered Air Forces, air divisions, wings, groups, squadrons, and flights. General McPeak wanted the wing commander to command the base and to be accountable for every unit on it.[45]

The first phase of the reorganization occurred in the Office of The Civil Engineer and AFESC, previously a separate operating agency, but now renamed as a field operating agency (FOA). The internal review process was described by General Ahearn as a "wire brushing" that was "intentionally vigorous and abrasive."[46] The Office of The Civil Engineer, with the help of AFESC, prepared viewgraphs. General Ahearn assembled each division head, plus General McCarthy, the Deputy Air

Force Civil Engineer, and Gary Flora, the Associate Civil Engineer, to participate in the briefing.[47] Before the briefing occurred, General Ahearn learned that General McPeak only allowed two poster boards to brief from. The briefing room contained a clear table and two easels. As Col. Marshall W. Nay, Jr., described that meeting that occurred on 11 March 1991,

> When we went downstairs that morning…at 9:00 a.m., the full Colonel Exec came out and said, "Only two of you guys are coming in here." So they agreed it was going to be General Ahearn and I. We started giving the briefing and I felt that he thought we were almost like a corps, an independent corps, you know, stovepipes and things like that.[48]

General McPeak asked some hard questions about the Air Force civil engineer organization. He questioned the role of the Air Staff in planning and readiness; he believed these were major command tasks. The organization of AFESC was particularly scrutinized. He questioned AFESC's role in training, the laboratory, and acquisition function. General McPeak showed particular interest in the organization of the environmental program.[49] Colonel Nay reported,

> He [General McPeak] asked General Ahearn the question, "Where do you guys do the environmental work?" And General Ahearn said, "Marshall, go ahead and answer that." He didn't like the answer I gave. It became clear to him that we had it spread out in many different locations because he had all those geographically separated units; and there was some of it in the Pentagon, some of over at Bolling at Building 500, some down here [at Tyndall], some at Wright-Patt [Wright-Patterson AFB]. He did not like that response. I felt really bad, but it was the truth, and you need to tell the Chief the truth.[50]

In summary, General McPeak expressed concerns over the entire organizational structure of Air Force civil engineering. He believed that it was not functionally organized and had too much overhead. The organization got its job done because it had good people.[51] Colonel Nay summed up the briefing,

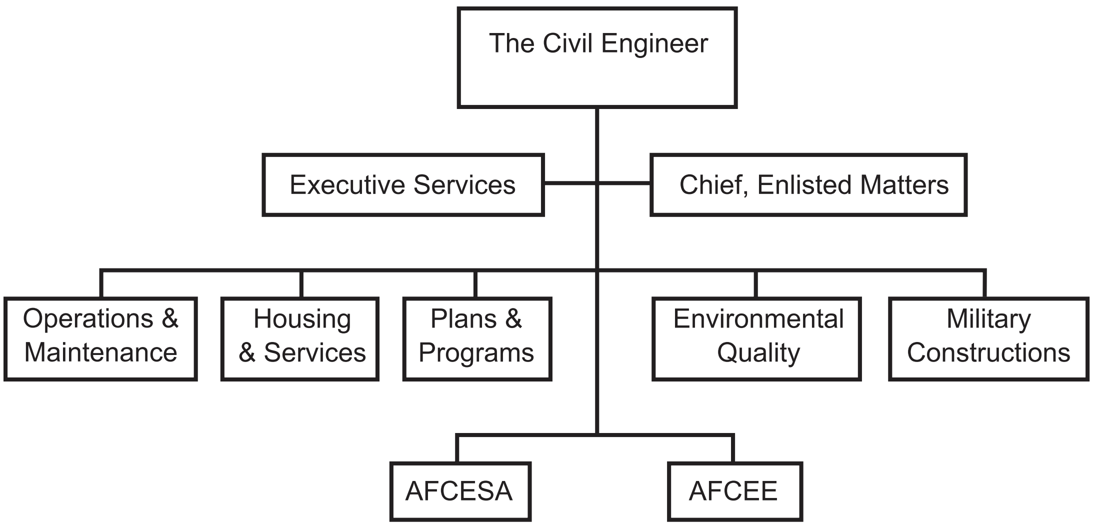
> I thought we were doing a good job, but what he saw there was redundancy and extra time and things of that nature. And so he told us in a pretty alpha-numeric way, come back in 60 days and answer that [environmental] question again, and the answer is going to be, "I'm going to do this in one location."[52]

As Gary Flora described the outcome of that first briefing,

> We gave General McPeak the briefing, and when we got done he basically said, "Your organization is all screwed up." General Ahearn said, "Okay, we'll go back and take another look at it, and we'll come back and brief you." We took a hard look at the organization and went back to the Chief as soon as we could get an appointment.[53]

The Civil Engineer Reorganization Briefing was presented again to General McPeak on May 7, 1991, followed by a presentation to the Secretary of the Air Force on June 26, 1991. The briefing slides summarized the core purpose of the civil engineer organization, its vision, past organization, and proposed new organization. The Office of The Civil Engineer in the Pentagon was supported by Executive Services and five directorates: Operations and Maintenance, Military Construction, Plans and Programs, Housing and Services, and Environmental Quality in the plan presented in May, and submitted for approval on June 26, 1991. The role of the Office of The Civil Engineer was refocused on formulating civil engineer policy, validating Air Force requirements, and allocating resources to meet those requirements.[54] The AFRCE offices that formerly reported to The Civil Engineer were inactivated and their manpower positions dispersed among the major commands. The major commands were assigned the role of interfacing directly with the contracting agents to design and to construct the Air Force Military Construction Program.[55] Proposed staffing for the Office of The Civil Engineer for FY91 was reduced from 447 to 170 (Figure 5.1).[56]

Figure 5.1 , Office of the Civil Engineer Organizational Chart, August 1991



Source: Maj. Gen Joseph A. Ahearn, "Civil Engineer Reorganization Briefing," May-June 1991, AFCEC History Office.

Civil Engineering's Core Purpose 1991

We are the Air Force team accountable for delivering the highest quality engineering and services support to our customers. We provide the **leadership, policies, resources, and oversight** to build and operate Air Force installations for global air power, shelter and sustain Air Force people, and protect the environment.

The Air Force Office of The Civil Engineer was supported by two field operating agencies (FOAs). The role of FOAs was to develop standards and procedures to execute Air Staff policy, and to provide technical support to the major commands and the field.[57] Major commands were charged with organizing, training and equipping Airmen. AFESC at Tyndall AFB, Florida, was no longer responsible for developing policy and training; its role now emphasized providing support to civil engineer organizations in the field and at the bases.[58] As described by Colonel Nay, AFCESA's mission was to "be the technical services focal point for major commands to facilitate executing policies and programs of the Secretariat and the Air Staff applicable to the base civil engineering missions."[59] AFESC's training detachment was removed and eventually transferred to the 823d RED HORSE Squadron. The name of the Civil Engineering Maintenance, Inspection, and Repair Training (CEMIRT) function was changed to become Civil Engineering Maintenance, Inspection, and Repair Teams. AFESC staffing was reduced from nearly 1000 to 547.[60]

A new FOA, named the Air Force Center for Environmental Excellence (AFCEE), was established at Brooks AFB, Texas. One reason Brooks AFB was selected as the location of AFCEE was that the Human Systems Laboratory already located there included some environmental aspects in its mission. This laboratory identified and investigated contamination and pollution on air bases. Brooks AFB was also located in a large metropolitan area with easy transportation access.[61] Three Environmental Regional Offices were transferred from the Air Staff to AFCEE and redesignated Regional Compliance

Office. The offices were located at Dallas, Texas; San Francisco, California; and, Atlanta, Georgia. The proposed AFCEE staffing for FY91 was 167 positions.[62]

An additional FOA was established on November 15, 1991, when the Closure Integration Division within the Office of The Civil Engineer, became part of a new field operating agency—the Air Force Base Disposal Agency (AFBDA) under the Assistant Secretary of the Air Force for Manpower, Reserve Affairs, Installations and Environment. Col. David M. Cannan moved from the Closure Integration Office to become AFBDA's first director. As property custodian for the 19 stateside bases that had been closed, or were slated to close, the agency had the total responsibility to environmentally clean up and transition those bases that were approved for disposal by Congress under the 1988 and 1990 base closure acts. Established with about 50 personnel, it was organized into a Property Disposal Office, Base Disposal Management Teams, Environmental Program Management Office, a Professional Services Team and Executive Support. [63]

Also in 1991, General McPeak, Chief of Staff, and the Under Secretary of the Air Force approved the transfer of certain real estate functions from the Office of The Civil Engineer to the Assistant Secretary of the Air Force for Manpower, Reserve Affairs, Installations, and Environment (SAF/MI) with functional oversight by the Deputy Assistant Secretary (Installations), Mr. James Boatright. These functions to be transferred to SAF/MI were policy, lease approvals, program/project validation, inventory management and accountability, and oversight; functions remaining in AF/CE were programming and budgeting for real property requirements. This new organization, named the Air Force Real Estate Agency (AFREA), was constituted and activated on August 1, 1991 as a FOA. AFREA was a 14-person, all-civilian organization located in Building 5681 at Bolling AFB. It maintained a complete land and facilities inventory and worked to acquire, manage, and dispose of real property worldwide for the Air Force. Mr. Anthony R. Jonkers was named Director of the AF Real Estate Agency. It reverted to the Real Estate Division in the office of the Deputy Assistant Secretary of the Air Force for Installations in 2001. [64]

Also during this time, General McPeak approved the transfer of explosive ordnance disposal (EOD), disaster preparedness (DP), and airbase operability (ABO) career fields to Civil Engineering. EOD transferred from the Munitions Directorate under the Assistant Chief of Staff, Logistics. DP was located at the Air Force Disaster Preparedness Resource Center at Lowry AFB, Colorado, and the ABO Branch was formerly part of the Air Force Air Base Operability office (AF/XOORB).[65] These areas were a natural fit into air base recovery activities. Capt. Charles Armour and CMSgt John J. Glover, EOD managers on the USAFE staff, helped oversee the transition to Civil Engineering. As demonstrated at Salty Demo, the two functions needed to work together. Following an enemy attack, EOD was tasked to clear aircraft operating surfaces of ordnance and engineers couldn't begin their work of repairing an airfield until EOD had completed its work. EOD needed the engineers' heavy equipment that was standing by waiting for them to finish. USAFE brought them together and tested the concept during several NATO TACEVALs with great success. Although some EOD units opposed the move to Civil Engineering, it soon became apparent that the union brought additional funding and improved support at all levels.[66] General Ahearn said,

> We embraced them into our group. We didn't want to lose them. The EOD guys clearly aligned to the first responder operations team. They wanted our leadership, and we, for whatever reason, created a pretty solid affinity with them, and they went quite well with the chem/bio guys. We learned this in the airbase operability exercise [Salty Demo 1985], that you've got to sweep up the whole playing field to keep it operating.[67]

The official transfer of these functions to Civil Engineering occurred in November and December 1991.[68]

Between June 26 and December 1991, the proposed organizational structure was revised once again when General McPeak decoupled Services from Civil Engineering. As General Ahearn recalled,

> I remember the general asking me, "Do you want to continue the relationship between Engineering and Services? Because Services is not a clear engineering function. Your mission in life is to take care of the infrastructure and the re-basing and downsizing." The question was also, "Where is there equal or better functional alignment?" The Personnel folks owned the club operations and the food service operations, and had a lot of complementary activities with Services. Having been a student of hospitality management, there was a far greater alignment with the functions of club management…Maybe we could create a synergy there, to integrate like functions and provide better food, housing, and fitness services for our people. The answer functionally was…yes. So, would the engineers be willing to support the whole set of those kinds of services with the same fervor and excitement? Well, of course, we would be. Could you get better focused in performing your core mission? Of course, we could. Would the Air Force be able to sustain the quality of services that would build up during this tenure? If you look at the leadership of the personnel folks, those guys and gals are really good. So, what…is the risk? The risk was, I found, somewhat minimal. It was tough, like letting your children go.[69]

On August 1, 1991, AFESC was renamed Air Force Civil Engineering Support Agency (AFCESA). By December 1991, Services was realigned under the Air Force Chief of Morale, Welfare, and Recreation.[70]

In November 1991, Secretary Rice and the senior Air Force leadership introduced a new vision statement to the Air Force, which read "Air Force people building the world's most respected air and space force…global power and reach for America."[71] In response to the new Air Force vision, General Ahearn, the Civil Engineer, wrote,

> I would observe that we [Civil Engineering] are the foundation of that power. The civil engineering community will perform its main missions:
>
> - Readiness—getting ready for war
> - Operations and maintenance on the base network girding the entire globe
> - Developing these bases through military construction and capital repair
> - Caring for the bases as stewards of natural environment through our environmental quality program, and
> - Delivering quality community areas, through such programs as family housing and housing for our unaccompanied people through dormitories, dining facilities, fitness centers, and other airbase community facilities.[72]

As a corollary to the new overall Air Force vision statement, Air Force civil engineers developed the following vision statement: "Civil engineer men and women—superbly led, motivated, trained and equipped—pacesetters in the best Air Force in the world." The accompanying mission statement was "Provide, operate, maintain, restore, and protect the installations, infrastructure, facilities, housing, and environment necessary to support aerospace forces having global reach and global power, in both war and peace."[73]

Objective Squadron

On the base level, the authority of the installation commander was strengthened. The basic rule of wing organization became "one base, one wing, one boss." Accountability for mission completion also was assigned to the installation commander. Because of the additional responsibility, most major bases were commanded by general officers after the reorganization. Meeting this command preference while maintaining a reduced number of general positions, generals serving in headquarters were relocated to the field. Most deputy positions held by generals were eliminated throughout the Air Force organization. Support activities, including civil engineering, services, and security police, were organized under the Mission Support Group.[74]

The second phase of the civil engineer reorganization occurred at the installation level with the implementation of the "right-sized" objective civil engineer squadron (CES). General McPeak's goal for squadrons was to "standardize the objective squadron and fix functions within each flight, define the squadron's capability, and adjust manpower to provide the same capability at each location."[75] A presentation delivered as part of the Objective Wing Conference on September 27, 1991 illustrated the revised organization for the CES. Each installation CES was supported by 269 persons comprising a mix of military and civilian personnel. In early October 1991, General Ahearn formally questioned the manpower numbers presented in the September briefing:

> We cannot validate the core manpower numbers reflected on the original objective wing chart. Civil engineering manpower is mainly derived from the installation real property inventory, with adjustments made for population and location. The military component of the squadron, on the other hand, is a function of the wartime mobility and home station requirements. As a result, total squadron strengths vary widely. We see no value in fixing a "core" size and requiring all squadrons to request adjustments. We recommend unit end-strengths be determined according to manpower standards at major command level.[76]

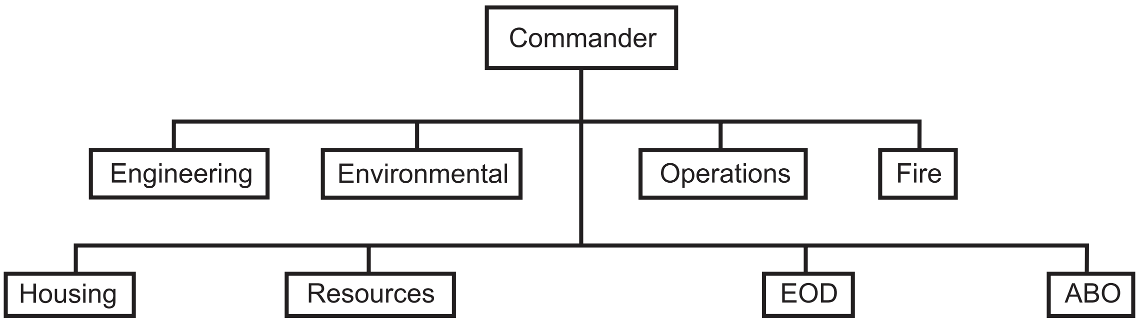
On January 18, 1992, General McPeak approved the civil engineer objective squadron organization staffed by 269 persons as presented in September 1991. For the first half of 1992, Brig. Gen. James E. McCarthy, then serving as Assistant Civil Engineer, turned to the Air Staff, AFCESA, major commands, and installations to define ways to meet the personnel cuts required under DMRD 967 and the severe manpower constraints in the objective squadron model. A series of workshops were held to answer the questions: "How do we make an Air Force Civil Engineering Squadron? What does it take to make sure that the squadron does what it needs to do?"[77] The effort involved a variety of vested parties, including the Air Staff, AFCESA, Air Force Management Engineering Agency (AFMEA), major commands, and installation personnel. The assistance of the AFMEA's Air Force Civil Engineering Management Engineering Team (AFCEMET) was particularly valuable in working on the manpower issues.[78]

On May 21, 1992, General McCarthy submitted a staff summary sheet to the Vice Chief of Staff, U.S. Air Force, reporting the results of the intensive study of staffing levels proposed for 64 bases that combined the DMRD 967 personnel reductions and the personnel constraints of the objective squadron model. The reduction of civil engineer manpower was projected at 11 percent by FY97. The summary requested the approval of additions to the objective civil engineering squadron staffing that increased the core squadron size from 269 to 283 to incorporate the EOD, ABO, and DP functions. General McCarthy concluded the staff summary sheet:

> We have reviewed the results of this study with the major command Civil Engineers. We believe the Objective CE Squadron, if fully manned and augmented by contract services described in the study, can support Air Force missions and sustain the quality of our installations.[79]

The organization presented in the staff summary sheet was led by the Squadron Commander who oversaw eight flights. The term flight was introduced to conform to the terminology in use in the Air Force wing structure.[80] The Housing Flight, the Resources Flight, the Engineering Flight, and the Environmental Flight provided professional services. The Fire Protection Flight, the EOD Flight, and ABO Flight provided emergency services, while the Operations Flight oversaw operations. On June 9, 1992, the Vice Chief of Staff approved the staff summary sheet.[81] The new structure of the base squadrons was announced to the civil engineer community in August 1992.[82] Implementation of the objective squadron began in October 1992 (Figure 5.2).[83]

Figure 5.2 Objective Squadron, 1992



Source: Perry Sullivan, "Objective Wing Approved," CE Update, Vol 4, No 1, August 1992, 1.

Major Command Reorganizations

The civil engineer structure at the major commands also was reorganized; this reorganization was broad reaching during the merger of two commands into one structure. AFMC resulted from the merger of AFLC and AFSC in 1992. "It was the merging of two very different philosophies," stated the major command Civil Engineer Brig. Gen. Robert J. Courter, Jr. As a result of this merger, a new management structure was established at the Headquarters AFMC. Five mission element boards were formed to focus management attention and to allocate financial resources. Base Operating Support (BOS), one of the five boards, was chaired by General Courter, AFMC Civil Engineer. The BOS board comprised representatives from 16 functional areas including civil engineering, medical, environmental, security, services, legal, supply and transportation personnel, and wing and support group commanders. The BOS board was "responsible for all strategic planning and resource allocation decisions of BOS across AFMC."[84] General Courter envisioned that combining all functional areas into a single organization on the base level would eliminate duplicated administrative efforts. BOS teams formed on the base level would have one resource manager, one central control center, one single programming and planning staff, and a single work control point instead duplicating functions for each functional area.[85]

In ACC, the merger of TAC and SAC missions and personnel required the Headquarters ACC civil engineer staff to analyze rigorously the missions, responsibilities, and business practices of both former commands. The new civil engineer organization was created by incorporating the best practices from both commands. One innovation adopted by the ACC civil engineer staff was the formation of the Civil Engineer Technical Support Office (CETSO). Brig. Gen. Michael A. "Mick" McAuliffe, ACC Civil Engineer, realized that his staff included functions that were not truly staff functions, so he established CETSO to provide these services to the field. CETSO was operationally based and directly supported base personnel. General McAuliffe also expanded the new command's environmental program under the direction of Col. John Mogge the Chief of Environmental Programs at ACC. The staff grew from 12 to 85 and included future leaders such as Capt. Timothy A. Byers and Capt. Theresa C. Carter, both later reached the rank of major general and served as The Air Force

Civil Engineer. General McAuliffe and Colonel Mogge set out to establish the standard for the Air Force and the Department of Defense, "We set out to establish a new, deeply embedded environmental ethic. We were set on achieving cultural change. We transferred responsibility down to the people who work in the areas of high environmental concern. We also set out to clean up the environment at each of our bases…. We are constantly being used as an example to follow by other federal and state agencies." With strong support from ACC's commander and cross-functional support from within the command, the ACC Environmental Leadership Council and Environmental Leadership Board raised the command's environmental program to levels.[86]

The activation of Air Mobility Command was more than just a name change, it created a new command presence at 17 bases and 105 tenant locations as the command carried out its Global Reach mission. When then-Brig. Gen. Eugene A. Lupia left HQ SAC and moved to HQ AMC, the position became the Director of Civil Engineering, reporting directly to the commander. He faced many challenges: an aging infrastructure, a command whose Civil Engineering force was primarily in the Air Reserve components, integrating explosive ordnance disposal and disaster preparedness into the career field, and building an environmental program. He increased the command's environmental staff from 2 to 16 in his first few months and asked Lt. Gen. Walter Kross, AMC vice commander, to chair the AMC Environmental Protection Committee, elevating it from a civil engineering program to a command program.[87]

Research &Development (R&D)/Laboratory Transfer

On December 4, 1992, the Research, Development, and Acquisition Directorate at AFCESA was transferred to the new Air Force Materiel Command (AFMC). The Environics Laboratory became a directorate of the Armstrong Laboratory under the Human Systems Center at Brooks AFB, Texas, although the laboratory physically remained at Tyndall AFB, Florida. Civil engineering research and the airbase systems and development acquisition were transferred to the Aeronautical Systems Center and placed under Wright Laboratory at Wright-Patterson AFB, Ohio. One branch office for civil engineer research remained at Tyndall AFB, while a branch office for airbase systems and development acquisition was retained at Eglin AFB, Florida.[88] This realignment consolidated responsibility for all Air Force laboratories under a single command, which controlled both personnel and budgetary resources for all Air Force R&D work. In the case of Environics, the realignment provided additional R&D personnel to work on environment cleanup, remediation, and pollution control and prevention strategies. The realignment allowed AFCESA to focus on its core missions, although the organization retained the responsibility for developing requirements for civil engineering R&D work for which commercially available products were not a viable solution. AFCEE oversaw the requirements for environmental quality R&D.[89]

General McCarthy worked to assure that civil engineers had direct input into environmental R&D projects. He worried that civil engineer R&D would be buried within a large lab and would be a target for future manpower reductions. General McCarthy worked closely with senior personnel at Wright and Armstrong Laboratories to ensure that civil engineer personnel were assigned to their staffs, but remained physically at Tyndall AFB, Florida.[90] The relationship among AFCESA, AFCEE, and the laboratories was formalized in 1994.[91]

Effects of Reorganization on The Civil Engineer Office

On the Pentagon level, the Office of the Civil Engineer experienced a major reduction in staff. During the 1980s, the Directorate was headed by a major general with a military deputy, who typically was next in line for the top job; this arrangement ended with General McCarthy. As Gary Flora explained,

> Chief of Staff Gen. [Merrill A.] McPeak…was trying to assign more general officers as wing commanders, and they looked around for places to get more positions. Ours was one that got reassigned. When [Maj. Gen. James E.] McCarthy was promoted to one-star and had confirmation problems going to two-star, [Col.] Todd Stewart sat in as a colonel deputy. He was there waiting for an assignment. He was the *de facto* deputy, although we didn't have the position. Then when he and I left, about the same time, in early 1994, they decided not to have a military deputy. The civilian would act in the deputy role. So, not only did we lose the general officer slot, but we lost the colonel slot, too.[92]

The reorganization between 1990 and 1992 streamlined the programming and funding process. Programs and construction projects formerly were reviewed by a Program Review Committee (PRC), the Air Staff Board, and the Air Force Council before submission to the OSD. One review panel of the PRC was the Facilities Panel that reviewed all new construction projects and weapons support facility requirements. During the reorganization, the Program Review Committee and the Air Staff Board were eliminated and Resource Allocation Teams were established. The Civil Engineer lost control over allocated funds for civil engineer programs and ceded the ability to advocate directly for them. Shrinking budgets required that all programs and projects be grounded in compelling mission requirements and supported by solid economic analysis.[93]

The accumulated organizational changes between 1989 and 1993 necessitated revision of all Air Force regulations, pamphlets, and manuals to reflect the new organizational structure. Through these revisions, the number of Air Force regulations was reduced by 20 percent and the total number of pages of regulations was reduced by 40 percent.[94] At this time, Air Force Regulations were rewritten and became Air Force Instructions.[95]

Civilian Reduction in Force

Change in the DoD structure was not yet over. On 20 February 1993, President William Clinton issued Executive Order 12839 that called for a Federal civilian reduction in force of 100,000 persons between FY93 and FY97. DoD faced a reduction in force of 62,000 civilians. As a result of the National Performance Review, "Creating a Government That Works Better and Costs Less," conducted between March and September 1993, the elimination of an additional 104,000 DoD civilian positions was recommended by FY99. Air Force reductions originally numbered 48,300 civilian positions, but were reduced to 39,700 between FY95 and FY01.[96]

In 1995, the total estimated number of active-duty Air Force personnel was 383,000, down from 900,000 in the 1960s. In 1995, the total number of active duty Air Force civil engineers numbered 50,000, down by about one-third from the number of civil engineers active in 1988-1989.[97] Between 1986 and 1995, the "total obligational authority" of the Air Force budget declined 34 percent; personnel strength declined 27 percent; and, the total number of aircraft, including the Air National Guard and Air Force Reserve inventory, declined 20 percent. The number of bases was reduced by 24 percent.[98] Civil engineer personnel statistics between 1989 and 1999 further illustrated the drastic manpower reductions. In 1989, active duty military and civilian personnel numbered 63,400, of which 31,900 were military and 31,500 were civilian. In FY90, the number of civil engineer personnel totaled 60,100. By FY92, the number of civil engineer personnel had dropped to 54,100, comprising 28,300 military and 25,800 civilians. By FY95, the number had dropped to 44,700 civil engineer personnel. By FY99, the number was 39,600, of which 18,900 were military and 20,700 were civilians.[99]

Air Staff Reorganizations 1994-2000

In February 1994, the term “Civil Engineering” used in all organizational titles was shortened to Civil Engineer.[100] General McPeak had considered shortening the name to simply “Engineer” but ended up only removing the “ing.” Civil Engineering squadrons became Civil Engineer squadrons. Each major command now had a Civil Engineer office.

New civil engineer occupational badges, designed in 1993, were approved for distribution in early 1995. The badge was part of an initiative instituted by General McPeak to provide badges to all Air Force career areas that previously had none.[101] The badge was designed by Col. (later Maj. Gen.) Todd I. Stewart, who also wrote its heraldic statement. General McCarthy slightly altered some aspects of the design to improve its appearance. The badge was formally approved by the beginning of 1995 and available for distribution.[102] A sterling silver version of the civil engineer badge was also purchased and presented to then Civil Engineer General McCarthy by Chief Master Sergeant Larry Ward. When General McCarthy retired, he pinned the badge on his successor, General Lupia. General Lupia then passed the badge onto General Robbins and the tradition continued.[103]

CIVIL ENGINEER OCCUPATIONAL BADGE HERALDIC SIGNIFICANCE

The gear wheel and compass have historically been used to represent the engineering profession, in both the military and private sector.

In the military, the gear wheel was used on the Army Air Force Technician badge for those persons associated with aviation engineering. The gear represents the essence of engineering: applying scientific principles and technology to practical ends. The gear is an especially appropriate symbol for Air Force Civil Engineers because the gear is an element (representing the built environment) that meshes with others (weapon systems and trained personnel) to enable a larger machine (the Air Force) to perform its function. The gear is used here as the common symbol to represent all Air Force engineers, having many diverse skills, who are employed worldwide in providing, sustaining, and protecting the installations and environment the Air Force needs to project Global Reach and Global Power.

The compass is a precision tool historically used by all engineers in designing and constructing facilities and equipment. More specifically, the compass is an engineering tool used to describe the boundaries of an effort. Placing the gear within the compass is intended to symbolize that all of the diverse engineering specialties included within the Air Force Civil Engineers are represented by the badge. Finally, by superimposing the traditional Air Force wings on the legs of the compass, the badge is intended to portray the fundamental linkage between engineering and aviation and that the built environment provided by Air Force Civil Engineers is the foundation supporting Air Force missions and people.

In October 1995, Maj. Gen. Eugene A. Lupia established the Directorate of Facility Privatization (HQ USAF/CEI) in The Civil Engineer office.[104] The new directorate initially handled housing privatization initiatives, but its responsibilities were expanded to include utilities privatization, as well as outsourcing of various civil engineer functions. Major commands soon established similar offices to oversee these initiatives for their bases.[105]

On November 1, 1995, the Air Staff programming structure was amended to correct deficiencies in resource allocations. To ensure adequate representation of mission requests for funding, the Air Staff instituted an enhanced corporate organizational structure similar to its 1980s structure. The new structure introduced mid-level reviews, realigned resource allocation teams into mission and mission area support panels, and created 71 integrated process teams to serve as the Air Force points of contact for specific services and products. The Civil Engineer chaired the Installation Support Panel. The purpose of the panel was to allocate resources to support and to maintain the Air Force network of bases. Integrated process teams reporting to the Installation Support Panel were established for Environmental, Base Realignment and Closure (BRAC), Air Base Performance, Base Operating Support, Military Family Housing, Real Property and Maintenance Activities, Military Construction, and civil engineer programs, such as RED HORSE. Funding for distribution to activities under the Installation Support Panel was proposed at $6.5 billion for FY97.[106]

On January 1, 1997, the senior leadership on the Air Staff was reorganized again into a more efficient and effective structure. The Office of the Civil Engineer was moved under the newly constituted Deputy Chief of Staff, Installations and Logistics (IL), Headquarters, U.S. Air Force. Some objectives of the reorganization were to promote clear lines of authority, unite operations under one function, consolidate responsibility for installation support, institutionalize doctrine, improve general officer presence, and reduce headquarters staff. The Civil Engineer retained a seat on the Air Force Council, and continued as the chair of the Installation Support Panel.[107]

By 1997, the Office of The Civil Engineer at the Pentagon was led by The Civil Engineer and a civilian Deputy Civil Engineer. The organization had the following six directorates: Engineering, Housing, Programs, Operations, Environment, and Facility Privatization. Also reporting to the Civil Engineer were the two FOAs: AFCESA and AFCEE.[108]

Wartime Manpower Requirements

The reduction of military personnel through DMRD 967 and the implementation of the objective squadron greatly impacted the wartime manning allocations. Wartime manning requirements were reviewed four times between 1994 and 1998 in response to evolving national military strategy, defense planning guidance, and operational plans. These elements determined force structure. Other influences on force structure included quadrennial defense reviews, the president's budget, contracting decisions, personnel policies, and individual career choices within the Air Force.[109] Wartime manning requirements were categorized in unit type codes (UTCs), which detailed the skill sets required to support a war effort or deployment. The UTCs were linked to the Air Force Specialty Code (AFSC) that described an Airmen's skill set in peacetime. Each Prime BEEF team was based on UTCs that translated to the number of personnel and the skill sets assigned to the team.

Prior to and during the Gulf War in 1990, the Prime BEEF teams were organized into 200, 150, and 100-person teams. These teams were defined by the base recovery requirements for completing rapid runway repairs for a specific number of craters in the runway within a specific number of hours. Some members of the teams were trained as supplemental equipment operators for specific pieces of equipment for rapid runway repair. One lesson learned during the Gulf War was the advantage of teams structured in smaller, more flexible numbers.[110] In 1991, Prime BEEF teams were restructured into 50 and 100-person UTC groups and two groups of firefighters composed of 12 and 24-person UTC groups.[111]

By 1992, after implementation of the civil engineer objective squadron, 152 military personnel were assigned to a typical base civil engineer squadron. That number became the basis of the installation's Prime BEEF team. One hundred members of the team were engineers organized in a 100-person UTC to support one independent flying squadron. Firefighters formed one 24-person UTC to support one independent flying wing and a second 12-person UTC to support one dependent flying wing. The balance of the 152 military personnel comprised nine EOD personnel, five DP personnel, one first sergeant, and one in the commander flight. Numbers of UTCs were augmented based on wartime requirements either through adding increments of complete UTC packages or by adding individual authorizations to support theater mission requirements above the single UTC set.[112]

In 1993, General McPeak required all Air Force functional areas to review their UTCs and to justify them. General McCarthy also took a hard look at the Air Force civil engineer UTCs. At that time, civil engineering had 123 UTCs. Joseph "Joe" Smith (CMSgt ret), who worked at AFCESA, was tasked with the review and received the following instructions from General McCarthy: "He said, 'I want my UTCs to be capable of an Al Kharj AB [Saudi Arabia] model beddown.' That's when we developed our UTCs into the 132-person package, every one of them capable in an Al Kharj-type situation, where it was a true bare base scenario where they had everything to do, and to set up a Harvest Falcon package."[113]

The restructuring of the UTCs was based upon setting up a Harvest Falcon package over a 30-day period. The task required personnel expertise in power production, electricity, and water. The review resulted in 23 UTCs in civil engineering. General McCarthy preferred large UTCs so that the standard base package of 132 personnel included the firefighters and other necessary skills. The standard base package was defended up the chain of command through General McPeak. Later during the 1990s, the number of UTC classifications in civil engineering was increased over the 23 types.[114] Making the case for large UTCs to Air Force leadership was a tough sell, as Joe Smith well remembered,

> We were defending the UTC structure and why we needed 132 people. There were General McCarthy, Mr. [Gary] Flora, and most of the MAJCOM CEs sitting around the table. "How many electricians do you have?" they asked. I said, "I've got to have this number of power pro[duction] people." "Why do you need them? How many crews is that going to be?" I had to be able to defend that down the line. I said, "If we're operating in a dispersed, worst-case scenario at a bare base, that means more than one power plant, 24 hours around the clock. We're going to have one man on the night shift and one man and a maintenance person on the day shift." I had to defend every position. "And not only do I not have enough power pro—I've got to have electricians, too, to fill in." We went through the entire gyration, what every person's position was and what they did, and it was personally approved. It's interesting that I didn't have a First Sergeant assigned to the team—it wasn't a wartime requirement. But by the time I got out of that room, they convinced me I'd better have a First Sergeant.[115]

The final result of the manpower wartime requirements review was to realign the Prime BEEF teams for the completion of bare base beddowns rather than rapid runway repair and base recovery. Joe Smith, after analyzing the wartime capabilities, developed the essential Prime BEEF UTCs. The new alignment comprised a 132-person "lead-in" team with a 61-person "follow-on" team. The 132-person team was divisible into smaller groups to respond to smaller deployments.[116] By 1998, 127 personnel were assigned to a lead-in team.[117]

In 1997, then Civil Engineer General Lupia posed the question to AFCESA "Total Force, how many blue-suit engineers are needed for two major theater wars; by major command, by bases (and) by Air Force specialty?" Thus began another blue-suit manpower review. The formula for calculating the total civil engineering required manpower was complicated and analyzed 15 categories covering the major areas of mobility, in-place forces outside CONUS on forward bases, and forces stationed inside the United States. In addition, the manpower requirements to support the operations plans for two theater wars were reviewed along with the manpower projected for the simultaneous construction of three additional bare bases and military operations other than an armed conflict. Personnel from Air Staff and AFCESA compiled the numbers using a systematic methodology. The methodology won praise and was adopted as a template for other functional areas. The methods were validated both by the Vice Chief of Staff and by four-star generals briefed at CORONA. The calculations resulted in a projected number of 28,370 Air Force civil engineers.[118] By 1998, the number increased to 28,401, comprising 15,924 active duty personnel, 4,731 Air Force Reserves, and 7,746 Air National Guard.[119]

In his experience, General Lupia said,

> Most times what really happens is that we get UTCs, then we see what the requirement is, and we match the UTCs with the requirement. You always say, "Well, in this case I need more electricians or less electricians." I recall when I was at AMC and we went to Somalia. We had to take the standard UTCs, and we had to add a lot more power linemen to them, because one of the big jobs there was putting up an electrical distribution system. You couldn't send the standard M1A1 UTC; you had to doctor it up. I think you do that literally every time you have a deployment.[120]

Air National Guard and Air Force Reserve

The role of the Air Force Reserve and the Air National Guard (ANG) also dramatically changed during the 1990s. ANG and Reserve personnel became more integrated into Air Force Operations at all levels, forming an increasingly important sector of the Total Force. These units became fully integrated into all war and contingency plans and were deployed to support both small-scale and major operations.[121]

During the 1990s, the typical ANG civil engineer office comprised eight full-time personnel who supervised activities and managed training, in addition to approximately 12 state-funded employees who operated and maintained the facilities. Contractors augmented the work force. ANG Prime BEEF teams comprised drill positions that formed a tasked-based team focused on contingency deployments. By 1999, the ANG civil engineer personnel were restructured from a 132-person lead team to a smaller team with 69 engineer positions. The 69 positions also included firefighters. Follow-on teams were similarly sized. ANG also was preparing to add EOD units to some civil engineer squadrons to cover Air Force wartime shortfalls.[122]

ANG civil engineer personnel had top quality skill sets. Drill personnel often worked in construction positions in their full-time jobs and used ANG drill time to learn other crafts. ANG and Reserve had their own RED HORSE units that trained together and often were deployed to accomplish work in CONUS and at overseas locations. ANG civil engineers were always on call to their state governments to help in emergency situations.[123] In addition, both Reserve and ANG established Staff Augmentation Teams (S-Teams), 12-person teams that were highly mobile, highly trained, and very experienced civil engineers with many years on Prime BEEF teams, base civil engineering, or RED HORSE, and with secret clearances. ANG had six S-Teams, while the Reserve had three teams. The wartime tasking of these teams was to support headquarters staff at major commands. S-Team support included providing project designs during Desert Storm, damage estimates after Typhoon Omar, facility designs for the Republic of Korea, and humanitarian assistance to Thailand and Laos in return for aid with the recovery of MIAs during the Vietnam War.[124]

Integration among Reserves, ANG, and the active duty Air Force in terms of unit mission, resources, and leadership in a joint environment became a key element in the Total Force Policy by the late 1990s. A seamlessly integrated Total Force was seen as a cost-effective way to address future military challenges.[125] At the Pentagon, the concept of "Future Total Force" was under discussion by the end of the 1990s.[126]

Col. Samuel Lundgren, the Civil Engineer for ANG, worked diligently to integrate ANG civil engineers personnel with regular Air Force civil engineer units in a similar way that ANG flying units were integrated into the operational force. Colonel Lundgren's goal was to achieve,

> scheduled deployments to real world requirements, such as Northern or Southern Watch and Bosnia. We want to partner with the Air Force for scheduled participation in the ongoing civil engineer contingency support mission around the world. We can help with some of these deployed contingency missions using ANG civil engineer units that would rotate every 15 or 21 days as their regular annual training requirement. By deploying ANG civil engineer units in scheduled annual training status, we can help relieve the opstempo and give active duty units a break in the mission. Our goal is to deploy about one-third of our ANG civil engineer force structure overseas in direct support of real-world Air Force civil engineer missions on an annual basis.[127]

Another goal of furthering an integrated Total Force was to affect partnerships at the wing level and, subsequently, at squadron level. The activation of the 819th RED HORSE squadron at Malmstrom AFB, Montana, with its melding of one-third ANG from the 219th RED HORSE Squadron (formerly members of the 120th CES at Great Falls International Airport, Montana) and two-thirds active duty personnel was a precursor of reaching a higher level of Total Force for civil engineering personnel.[12]

Reactivation of 819th RED HORSE

The 819th RED HORSE Squadron was reactivated June 1, 1997 at Malmstrom AFB, Montana. It became the first "associate" RED HORSE unit in the Air Force, composed of two-thirds active duty and one-third Air National Guard personnel.[129] Col. Michael A. Aimone was the first 819th Commander and Col. Gary Schick was the 219th RHS commander. The squadron had a renowned history dating from its first activation on February 1, 1966 at Forbes AFB, Kansas. Shortly after its activation, the 819th RED HORSE deployed to Ban Sattahip Royal Thai Air Force Base, Thailand, and, in May 1966, to Phu Cat AB, Vietnam.[130] In 1970, the 819th RED HORSE moved to Tuy Hoa AB, Vietnam to assist with closing the base. While stationed in Vietnam, the RED HORSE completed tremendous amounts of construction. Almost all construction including buildings, earthen revetments, and pavements at Phu Cat were completed by RED HORSE, making it the only base in Vietnam with that claim. The unit was awarded "seven Vietnam campaign honors … and the Republic of Vietnam Gallantry Cross with Palm."[131] Additionally, the 819th received the Air Force Outstanding Unit Award with Combat "V" Device three times during the Vietnam War.[132]

After Tuy Hoa, the unit's home station changed to Westover AFB, Massachusetts, until 1973, when it changed to McConnell AFB, Kansas, and again it changed to RAF Wethersfield in 1979. The 819th RED HORSE was inactivated August 1990.[133] By the time of the unit's inactivation, the 819th RED HORSE had received the Outstanding Unit Award seven more times.[134]

Doctrine Development

In April 1991, Air Force Manual 3-2 entitled, *Civil Engineering Combat Support Doctrine,* was published, the first-ever doctrine manual for Civil Engineering. This publication represented the culmination of several years of research and discussions among civil engineer personnel. In 1988, a doctrine working group comprising Maj. Alfred B. "Barrett" Hicks, Jr., AF Directorate of Engineering and

Services, Plans Division; Lt. Col. Horst Haeusser, AFESC Readiness Directorate; and, Dr. Ronald B. Hartzer, Civil Engineering Historian, was formed. Retired Maj. Gen. I.B. Holley, a renowned Air Force historian and doctrine expert, served as special advisor for the effort. This group was tasked to review extensive background material and to draft the document. The initial doctrine draft was circulated for review among the civil engineer community in 1988, including a Blue Ribbon Panel comprised of leading active duty and retired civil engineers. The document was revised, and reviewed again in 1989.[135] Maj. Gen. Joseph A. Ahearn convened a gathering of retired civil engineer general officers and senior executive service civilians that he named as the "Founders" to review and validate the draft doctrine manual. During 1990, the document was submitted for review through higher Air Force headquarters. After convincing higher Air Force headquarters that civil engineer combat doctrine was needed, the document was submitted for final reviews to Air Force headquarters and major commands. The Air Force Chief of Staff approved the *Civil Engineering Combat Support Doctrine* on October 28, 1990 and was formally published on April 26, 1991.[136]

The focus of AFM 3-2 was combat support doctrine for Air Force civil engineers. As General Ahearn wrote in the foreword,

> Civil Engineering Combat Support Doctrine is intended to guide the organization, equipping, training, and sustaining, deploying, and employing of engineer forces in support of Air Force combat operations. It is derived from the study of war and other contingency operations. Commanders should use this doctrine to: learn from the past, act in the present, and influence the future.[137]

The doctrine clearly explained the role of the air base in the fighting mission in a theater of war. The wartime role of Air Force civil engineers was to prepare, to sustain, and to recover those bases if attacked. The four broad functions that civil engineers performed were defined as planning, acquisition, operations and maintenance, and recovery and restoration. The document contained references to the new realities of working internationally with host nations, environmental stewardship even during wartime, and both surge and low-intensity operations. General Ahearn was proud that the civil engineering combat support doctrine was broader than the Cold War and was serviceable during operations Desert Shield and Desert Storm.[138] [139]

By 1994, General McCarthy directed that AFM 3-2 be updated to reflect more clearly the role of the Air Force civil engineer in peace and war. In May 1994, civil engineer personnel from the Air Staff, major commands, FOAs, and direct reporting units met at Langley AFB, Virginia, to update the civil engineering doctrine. The draft produced by this group required only a single round of coordination with the Air Force Doctrine Center. On December 28, 1994, *Air Force Doctrine Document (AFDD) 42: Civil Engineer* superseded AFM 3-2. The new document was broader than AFM 3-2 and addressed the civil engineer's peacetime role in environmental work, economic security, space operations, disaster preparedness, explosive ordnance disposal, joint work environments, and military operations other than war (MOOTW).[140]

In 1996, work began on an Air Force-wide doctrine for all the functional areas, including civil engineering. Work on the Air Force doctrine continued between 1996 and 1999. In 1997, the Air Force civil engineers began work to update AFDD 42 and had completed a second draft by March 1997. However, this effort was subsumed into a larger project to produce a doctrine document for all combat support areas. On November 22, 1999, *Air Force Doctrine Document 2-4: Agile Combat Support* was published. This document included all of the various functions as part of the Agile Combat Support mission area and superseded the AFDD 42, and the Air Force civil engineer community no longer had a separate doctrine for their functional area.[141]

Civil Engineering Founders

The Air Force Civil Engineering Founders group was formed in the spring of 1989. Maj. Gen. Joseph A. Ahearn, then Director of Engineering and Services, brought the group of retired officers and civilians together for the first time on April 21 at Andrews AFB, Maryland. General Ahearn's goal was to discuss the future of civil engineering and review the draft Civil Engineering Doctrine Manual. Retired personnel brought a fresh outlook on the engineering field. Following retirement, many of them joined the private sector. This allowed them to provide new insight, while also utilizing their backgrounds as Air Force civil engineers.[142] In a 2008 oral history interview, General Ahearn, then retired, explained the group's purpose:

> The world was far bigger than just our community, and I thought we ought to draw on our heritage and the places that our heritage went after they left the Air Force, to see if there weren't gold nuggets that would help our capability multiply. We're a proud engineering community. Why don't we establish a fellowship chain that would never be broken, whereby we would always have some kind of event structure to welcome back our Founders and offer them an opportunity to tell us what they've learned since they've gone on to other things.[143]

The first gathering of founders comprised 33 participants, including retired brigadier generals, major generals, and civilians. General Ahearn's initial plans included using group members to serve as a Board of Visitors and on councils to provide advice regarding doctrine, technology, and development.[144]

First meeting of the Civil Engineer Founders at Andrews AFB, Maryland.

Civil Engineer Strategic Plan, 1999-2000

Work began on the civil engineer strategic plan by mid-1996 as the issue of the future role of the Air Force under "Global Engagement" was considered."[145] General Lupia hypothesized the civil engineer tasks likely to be the same in the future included forward deployments, beddown of forces, and base recovery. Operating and maintaining air bases during peacetime, providing contemporary and affordable housing for Air Force personnel, and maintaining quality environmental programs were also high priorities for the future.[146] When the senior Air Force leadership began the process of strategic planning for the overall Air Force, so, too, did the civil engineer organization for its functional area.

In early 1999, the first volume of the Civil Engineer Strategic Plan was published. Entitled *Future Security Environments and Planning Implications*, this volume addressed the future challenges to the Air Force civil engineer organization, including environmental stewardship, housing, and engineering functions during war and peace. The volume presented four future wartime scenarios in which the civil engineer community would likely participate. The four scenarios were "conflicts will migrate into space and the information operations realm; proliferation of weapons of mass destruction and disruption; turmoil and chaos in non-traditional environments; and, vulnerability of the U.S. homeland."[147] In this environment, the civil engineer community identified five core competencies:

- Installation engineering, comprising real property maintenance, operations, planning and construction, competitive sourcing, privatization and divestiture;
- Expeditionary engineering, comprising Prime BEEF, RED HORSE, and contingency contracting;
- Environmental leadership, comprising conservation and planning, pollution prevention, compliance, and cleanup;
- Housing excellence, including dormitories, family housing, and communities; and,
- Emergency services, including fire protection, explosive ordnance disposal, and readiness.

Volume 1 also identified two "end states" for the civil engineer community to achieve by 2025. These end states were defined as

- An efficient and effective base operating environment that maintains a strong sense of community and quality of life, and
- A corporate process and a strategic direction for basing that reduce unnecessary cost and improve operational efficiency.[148]

Volume 2 entitled *Mission and Modernization* was issued during 2000.[149] Volume 2 identified three civil engineer goals: quality engineering, agile engineering, and focused engineering. Also identified were five Civil Engineer Mission Essential Tasks (MET) tied directly to the civil engineer core competencies. Performance Measures were prescribed in order to assess the overall performance of the organization in achieving the METS.[150] Volume 2 also reviewed the current base-level civil engineer objective squadron organization and proposed several models to reorganize the squadron. One potential organization was the core competency squadron based on the five core competencies identified by the civil engineers. In this organization, the commander was supported by the following flights: Expeditionary, Emergency Services, Installation, Resources, Housing, and Environmental. Other models for organizing the base-level CES included the spectrum squadron, the focused squadron, and the public work center with wartime only staffing.[151]

The civil engineer organizational structure proposed in the civil engineer strategic plan for implementation by 2025 was the Aerospace Combat Engineer (ACE) Force structure. It would be built on

Civil Engineer Mission Essential Tasks from Civil Engineer Strategic Plan 2000

Provide Installation Engineering – Engineers will develop, operate, sustain, restore, and preserve bases, airfields, infrastructure, and facilities at Air Force locations, permanent and contingency, worldwide. Installation engineering is primarily focused on our network of bases that provide fixed operating locations and enroute infrastructure for operating, deploying, employing, and sustaining aerospace forces to the point of engagement and re-deploying and reconstituting the force.

Provide Expeditionary Engineering – Engineers will organize, train, equip, provide, sustain, protect, and recover combat ready forces to support expeditionary aerospace forces requirements. Expeditionary forces include military, civilian, and contract augmentation personnel. These forces will beddown, provide, sustain, defend, recover, transition, reconstitute engineer capabilities, and execute base denial activities to support global aerospace power.

Provide Housing Excellence – Engineers will ensure that all Airmen and their family members have access to adequate, safe, and cost-effective housing that meets or exceeds Air Force minimum quality and space standards in CONUS, overseas, and deployed locations. For the Air Force, commitment to provide housing applies equally to accompanied and unaccompanied personnel in both CONUS and overseas locations.

Provide Emergency Services – Engineers will provide the full spectrum of emergency services support to include fire protection, explosive ordnance disposal (EOD), disaster preparedness, and readiness support. Readiness support includes nuclear, biological and chemical protective operations, weapons of mass destruction protective operations, and consequence management of natural and manmade disasters. Fire Protection, EOD, and Readiness are mission critical operations required for safe aerospace operations regardless of the mission or location. These services must be provided without interruption in every location employing Air Force personnel and resources.[152]

a "cross-functional, capability-based" engineer force and represented an evolution beyond the current UTC-based Prime BEEF and RED HORSE taskings. Four capabilities were required under the ACE structure: a trained, equipped, and ready expeditionary force; superior technology incorporating information, intelligence, surveillance, and reconnaissance elements; organizational doctrine and force structure; and, integrated non-traditional and traditional engineering services.[153]

The Civil Engineer Strategic Plan offered a framework for the future of the Air Force civil engineer organization based on the vision and changing missions of the Air Force. It was based on the five civil engineer core competencies identified for the civil engineer community, identified areas for improvements, and established measurements to track performance.[154] It also provided an outline to reorganize the base-level civil engineer with a time line.[155] The strategic plan also was linked to current planning and budget programming processes to ensure that deficiencies identified in the plan would be corrected and to guide civil engineer modernization efforts.[156]

AFCESA During the 1990s

AFCESA Reorganization

The organizational reforms instituted throughout the Air Force during the early 1990s directly impacted the organization and future of AFESC. In January 1990, AFESC was commanded by Col. Roy G. Kennington, a Services officer. Under his command were the Support Staff, Computer Applications and Development, Readiness, Housing and Services, Engineering and Services Lab, Engineering and Services Program Office, Operations and Maintenance, and Construction Cost Management. In addition, AFESC fielded five Civil Engineering Maintenance, Inspection, and Repair Teams (CEMIRT) located at Tyndall AFB, Florida; Dover AFB, Delaware; Travis AFB, California; Kelly AFB, Texas; and, Peterson AFB, Colorado.[157]

During 1990, Colonel Kennington, as he retired, anticipated the reorganization and changes in the Air Force. He stressed that AFESC personnel must be prepared to justify their functions and activities and to account for their actions. While AFESC maintained high visibility in civil engineer units, other Air Force organizations had limited understanding and appreciation of AFESC's functions and roles. The commander counseled personnel throughout AFESC to review their programs, to reassess program requirements, to review the more that 250 regulations and manuals that AFESC managed, and to ensure support to the Air Force customers in the field.[158]

During the Gulf War (1990-1991), the role of AFESC was to assist in the planning and beddown of the expeditionary air bases to support the fighting mission.[159] AFESC personnel saw the fruition of readiness training for personnel and planning efforts to preposition deployable support packages, including Harvest Falcon, fire trucks, construction equipment, tools, and survival gear. AFESC personnel were deployed to SWA, and worked to support command headquarters. AFESC personnel worked to backfill the positions of deployed military personnel with ANG and reserve members under the Total Force concept. Col. Marshall W. Nay, Jr., Commander of AFESC, summed up the role of AFESC, "Desert Storm proved just how valuable planning can be. All of us in the Engineering and Services community had planned and practiced for the eventuality of war and, when the horn sounded, we were ready. We deployed and deployed on time. We built bare bases, set up shelters for people and equipment, and fed the troops."[160] General Ahearn praised the Center for its superb performance.[161]

On February 5, 1991, AFESC was designated a FOA.[162] This move refocused the mission of the organization on core military operations, an area in which AFESC had gained experience during the Gulf War. Customer service to support base civil engineer functions continued to be a major organization priority.[163]

During 1991, the organizational structure of AFESC was a subject of much discussion within the Air Staff. The structure of AFESC, as proposed in May 1991, comprised the FOA Commander who oversaw the executive services and eight directorates: Readiness; Fire Protection; Maintenance; Communication Computer Systems; Systems Engineering; Services; Research, Development, and Acquisition; and, Construction Cost Management. The CEMIRT teams stationed at Peterson, Travis, Kelly, and Dover AFBs were placed under the Maintenance Directorate.[164]

Col. Marshall Nay reviewed the command structure of AFESC in 1991 and concluded that reorganization was needed:

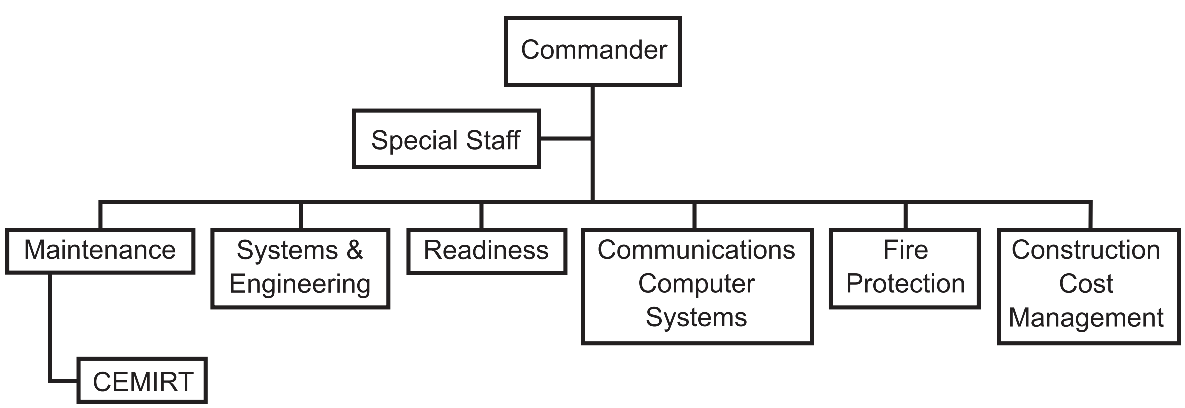
> [As a result of the organization's history,] numerous detached activities of the Center were not under its command, control, and authority. This also included the regional civil engineers and several operating locations in the Washington, D.C., area. This also created co-involvement between the Center and HQ USAF on numerous issues, with unclear demarcations of responsibility…In the meantime, representation of detached responsibilities on organizational charts created some confusion throughout the Air

> Force over many roles which appeared to be assigned to the Center…In retrospect, resource management was one of the key responsibilities of the Center without mission control over most detached activities…In fact, mission control was exercised only over operations and maintenance missions assigned to AFESC; readiness, including combat readiness training; construction cost management; housing and services; computer development and application; the program office; and the laboratory. Even among these latter missions, there was perceived unity that never existed. Each mission directorate functioned virtually separately in their day-to-day relationships with the field forces.[165]

On August 1, 1991, Headquarters AFESC was renamed Headquarters, Air Force Civil Engineering Support Agency (AFCESA).[166] On March 1, 1994, AFCESA became the Air Force Civil Engineer Support Agency.[167] In December 1991, the directorates established at AFCESA were Executive Services; Readiness; Fire Protection; Maintenance; Communications-Computer Systems; Systems Engineering; Research, Development, and Acquisition; and Construction Cost Management.[168] The Systems Engineering Directorate was a new directorate assigned the mission of providing professional and technical services to Air Force civil engineers at all levels. Under Mr. Dennis Firman as Director, Systems Engineering was focused on providing information and expertise for all infrastructure needs, including civil, mechanical, and electrical engineering. The field of infrastructure included airfield pavements, utilities and their operations, efficient energy usage, and utility rate management and litigation for contracted utilities. In addition, the directorate was charged with "fostering life-cycle engineering quality" for managing infrastructure systems, establishing standards, and publishing technical criteria.[169]

The reorganization recognized the transfer of Services from the civil engineer organization and strengthened the focus of AFCESA on field operations, airfield operations, and support of base workforce management. The restructuring affected the entire AFCESA organization. In the field of readiness, policy preparation was reassigned to the Air Staff, allowing personnel at AFCESA to focus on developing standards and performance criteria, while integrating air base operability with force readiness. The responsibility for readiness training was transferred from AFCESA to ACC. In 1993, ACC assumed responsibility for contingency training when the training site was relocated to Tyndall AFB, Florida. Engineering services at AFCESA were expanded to meet the reduction of specialty experts anticipated at the major commands. The former Program Office was merged with the Civil Engineer Laboratory to form the Research, Development, and Acquisition Directorate. This directorate oversaw research and development activities, as well as researched commercially available products and processes to enhance civil engineer requirements.[170] In 1992, the Civil Engineer Laboratory was realigned to AFMC (Figure 5.3).

Figure 5.3 AFCESA Organizational Chart, 1993



Source: AFCESA Visual Aid 11-1, "AFCESA Directory," January 1993, AFCEC History Office.

One function removed from AFCESA was the responsibility for assembling teams of military personnel for deployments. This function was transferred from AFCESA to major commands, or to the Air Force Military Personnel Center, which took over the selection of personnel to the civic action teams sent to Micronesia.[171] As General McCarthy recalled,

> Then during my tenure the question of AFCESA's role in deploying forces was questioned. Before that, I remember talking to Col. Marshall Nay, and he said that AFCESA was in charge of deploying people. He had gotten that notion because AFCESA would select people from across the Air Force for civic action teams and other peacetime deployments. We decided that going forward AFCESA would deploy only its own people. At the same time, Bud and I were undergoing pressure from the head of AF/PR [Programs & Resources]…to get rid of AFCESA. There was tremendous resentment toward the AFRCEs [Air Force Regional Civil Engineers] and AFCESA among some communities in the Air Force. They were a constant target, because of perceived stovepiping and empire building connotations. We went through intense scrutiny… If I were to say to the Air Staff, "AFCESA deploys major command or wing Prime BEEF teams," it would have been all over for AFCESA.[172]

Explosive Ordnance Disposal

A new area added to Civil Engineering and AFCESA was Explosive Ordnance Disposal (EOD). In November 1991, after moving to Air Force Civil Engineering, functional management for EOD moved from the Readiness Programs Division in Washington, D.C., to the Readiness Directorate at Headquarters AFCESA.[173] Before 1951, the Army provided EOD operational duties for the Air Force. On May 21, 1951, the Air Force assumed EOD responsibilities and assigned duties within the CONUS to HQ Air Materiel Command. The 1st Explosive Ordnance Disposal Squadron was activated on June 16, 1952 at Wright-Patterson AFB, Ohio.[174] By 1993, the responsibilities of EOD as part of AFCESA included: "monitoring and resolving peacetime and wartime manpower problems, developing standardized EOD equipment, training and operational requirements standards."[175]

EOD personnel performed highly specialized tasks, particularly during military operations and peacekeeping efforts. In addition, they provided expertise on range clearance efforts. For six months in 1998, EOD personnel worked to clear the Balboa Bombing and Gunnery Range in Panama of unexploded ordnance (UXO). The Air Force was obligated to turn over 353,895 acres to Panama as stipulated in the Panama Canal Treaty of 1977. Personnel assigned to the EOD teams began work in January with surface clearance, followed by "one-foot sub-surface clearance."[176] The operations concluded June 4, 1998. More than 4,000 UXOs were cleared, and "more than 25 tons of target residue and 18 tons of munitions residue" were recycled.[177] During FY00, EOD personnel disposed of more than 2 million munitions from bombing and gunnery ranges.[178] In support of Operations Noble Anvil, Sustain Hope, and Joint Guardian, EOD personnel were assigned the important mission of detecting and disposing of UXO in Kosovo.[179]

In addition to Air Force and Federal matters, EOD personnel frequently were called to assist civil authorities in such activities as dismantling methamphetamine labs. EOD personnel were trained to deal with the highly combustible ingredients used in those labs.[180]

Air Force EOD personnel had assisted the U.S. Army Central Identification Laboratory, Hawaii, in recovery operations in Southeast Asia since 1992. Joint Task Force-Full Accounting (JTF-FA) was established as a DoD program mandated by Congress to account for all prisoners of war (POW) and personnel missing in action (MIA). Teams assisted by EOD personnel deployed to known crash and burial sites of U.S. personnel to complete excavations, surveys, and the recovery of remains. In October 2003, JTF-FA and the laboratory merged to form Joint POW/MIA Accounting Command based in Oahu, Hawaii. [181]

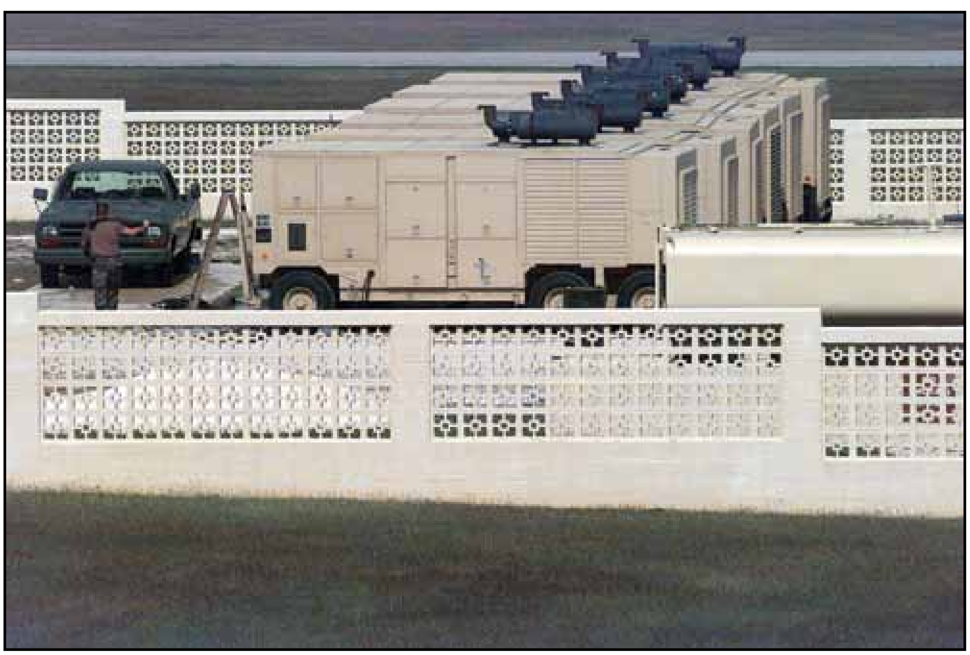
After the transfer of EOD to the Air Force civil engineering community, an annual award for the year's most outstanding EOD flight was established. The award was named in memory of SMSgt. Gerald J. Stryzak. Sergeant Stryzak served his entire Air Force career in EOD between 1962 and his death in 1980 as a result of an airplane crash at Cairo West AB, Egypt during an exercise.[182]

Disaster Preparedness

Before joining AFCESA in 1991, Disaster Preparedness (DP) was primarily a base-level organization with functional reporting to the Air Force Disaster Preparedness Resource Center at Lowry AFB, Colorado. Established in 1965, DP was a branch of Base Operations that reported directly to the base commander.[183] At AFCESA, DP personnel developed base-level plans and appropriate training packages for the "preparation, response and recovery" from nuclear, biological, and chemical (NBC) attacks.[184] Disaster Preparedness training was located at Lowry AFB until its closure in 1994. The technical school then moved to Fort McClellan, Alabama, and joined with the Army's Chemical Defense Training Facility. In 1998, Fort McClellan closed and both the Army and Air Force DP training were transferred to Fort Leonard Wood, Missouri.[185]

CEMIRT

CEMIRT remained one of AFCESA's traveling teams, though the number of teams was reduced. During the 1980s, five CEMIRT teams were positioned to serve U.S. regions. CEMIRT teams were stationed at Dover AFB, Delaware; Kelly AFB, Texas; Peterson AFB, Colorado; Travis AFB, California; and, Tyndall AFB, Florida. The CEMIRT region at Peterson AFB was closed in March 1992 to ensure maximum support to the critical overseas areas and to manage manpower reductions to CEMIRT. Four years later, the CEMIRT team at Kelly AFB, Texas, was shut down; its workload was divided between Travis, Tyndall, and Dover AFBs.[186] By the end of the decade, Tyndall AFB, Dover AFB, and Travis AFB still retained CEMIRT teams.[187] Throughout the decade, these teams provided valuable support



Mobil Emergency Power units are hooked up to power base housing at Andersen Air Force Base, Guam, after Typhoon Paka, by members of the Civil Engineer Maintenance Inspection and Repair Team (CEMIRT) Dover AFB, Delaware, and CEMIRT Travis AFB, California, and 15th Civil Engineers Squadron Hickam AFB, Hawaii, 1997.

to the major commands and bases. CEMIRT was particularly valuable during military deployments and base emergency situations. For example, in 1997, a two-person CEMIRT team travelled to Ridley Mission Control Center at Vandenberg AFB, California, after a malfunction in the alternate generators was reported. The CEMIRT personnel were able to quickly repair the failed generators.[188]

In addition to the work during Operations Desert Shield/Desert Storm discussed later in this chapter, CEMIRT teams also supported missions in SWA as part of Operation Southern Watch. A team of 11 deployed to SWA to repair generators and electrical distribution systems at Prince Sultan AB, Saudi Arabia. During the team's 45-day TDY, it repaired and performed maintenance on over 40 MEP-12 generators, as well as all primary distribution centers. CEMIRT team personnel performed routine maintenance on the generators at Al Jabar AB, Eskan Village, Riyahd AB, and Ali Al Salem.[189]

BASH

The first Bird/Aircraft Strike Hazard (BASH) program was established at AFCEC, Tyndall AFB in May 1975.[190] The purpose of the BASH program was to minimize hazards to aircraft and aircrews from collisions with wildlife during airfield activities. In 1993, 2,405 bird/wildlife strikes caused over $15 million damage to aircraft. The number of incidents grew to over 4,000 by the year 2000. While the vast majority, 97.6 percent, occurred below 500 feet, some high flying birds, such as turkey vultures posed a threat at higher altitudes.[191]

The BASH program was multifaceted and provided a range of high and low technology solutions. Eliminating ponded water from around runways reduced the attraction to some bird species, such as ducks and geese. Removing tree species, which provided both food and cover, from areas near active airfield operations also proved effective. Solutions as simple as controlling the height of the grass alleviated bird strikes. Maintaining grass height between 7 and 14 inches made the grass too short for ground nesting birds, yet too tall for ground feeders to feel comfortable in their surroundings. In some cases, local falconers were hired to periodically reduce and discourage bird populations around runways. Other low-tech solutions included using dogs trained to harass birds, pyrotechnics, loud noises, and anti-perching devices to discourage the birds from frequenting the area.[192]

More technologically sophisticated approaches also were employed. Predictive modeling was key to providing strategies to minimize bird strike hazards. Satellite telemetry was employed to monitor bird flight behavior and to determine location and altitude of birds. When this data was compared with geographic and weather factors, the results allowed schedulers and planners to avoid high risk areas.

Migratory patterns also were considered in BASH planning. One route in the Florida panhandle, known as SR-101, had "an unprecedented 36 strikes in 1993."[193] Seventy-two percent occurred in September and October, peak migration months, and between 7 am and 12 pm. This information assisted planners in scheduling training and flight activities to avoid these areas. A similar operation was undertaken at the Dare County Bombing Range, North Carolina, using marine radar to track the movement of waterfowl and birds of prey. Some wildlife hazards required more serious intervention. An over-population of deer at Whiteman Air Force Base, Missouri, required controlled hunting to cull the population and minimize deer strikes on the runway.

In 1994, the BASH program was moved from Tyndall AFB to Headquarters Air Force Safety Agency. From this new organization, BASH teams worked not only with the Air Force, but Navy, Marine Corps, Army, allied nations, and the private sector on a time-available basis. BASH teams also were actively involved in United States and international congresses on bird strikes, ornithology, and civil aviation, and promoted compatible land use development in the vicinity of runways.

Cost Estimating Programs

AFCESA was particularly proud of the Construction Cost Management Analysis System (CCMAS) software program. This system was developed by Tom Burns and the Construction Cost Management Directorate to evaluate and to manage project construction costs using parametric cost estimating techniques. The system was a major success in identifying potential costs for high profile Air Force construction projects. CCMAS received a boost in 1989 when the U.S. Congress authorized the use of the parametric cost model instead of the 35 percent design estimate traditionally submitted for MILCON projects.[194] Some advantages of CCMAS were timeliness and accuracy. Using CCMAS, a cost estimate took eight hours to prepare rather than 320 man-hours using manual cost estimating methods. Accuracy of the system was within 5 percent of the actual completion costs. This accuracy was validated over nine months when $10 billion worth of construction projects were analyzed using the system.[195]

During September 1990, Army, Navy, and Air Force representatives reviewed the CCMAS system for DoD-wide use. CCMAS became incorporated in the Tri-Service Automated Cost Engineering System (TRACES). TRACES operated on a personal computer and was linked to an Army program called Microcomputer Aided Cost Engineering System that used a quantity estimating system.[196] CCMAS began to be distributed to Air Force users during 1991. By April 1991, the system was in use at the AFRCE-Central Region. Moody AFB, Georgia, began using the system by June 1991, followed by Headquarters ACC in July 1991. By March 1992, the system was in use by all the major commands.[197]

In 1992, CCMAS was patented and AFCESA planned to distribute the software free of charge to Federal agencies.[198] However, TRACES, which was built on CCMAS, became more widely available because it ran on personal computers. TRACES software was first distributed to the Air Force in November 1992 and quickly was upgraded by May 1993 to include 68 parametric models, 36 site work and utilities models, a runway/taxiway model, and a contractor cost model. By June 1993, users of TRACES numbered over 170.[199]

AFCESA also was involved in the development of the Remedial Action Cost Estimating and Requirements (RACER), a cost estimating tool for environmental remediation projects.[200] This program was developed jointly by the Department of Energy and AFCESA to support environment restoration, compliance, and pollution prevention. RACER had two components. The Remedial Action Assessment System supported the Installation Restoration Program (IRP). The second component was Environmental Estimating (ENVEST) for project costs. Extensive user testing of ENVEST was completed by March 1992.[201] The first version of the software was released in July 1992, followed by an upgrade in September 1992.[202] By January 1993, RACER had 375 registered users and was adopted by the Department of the Interior for remedial action programs. An upgraded version of RACER with improved and expanded modeling was scheduled for release in May 1993.[203] By June 1993, the ENVEST portion of RACER had more than 400 users.[204] RACER was formally accredited under DoD requirements for verification, validation, and accreditation in June 2001.[205]

AFCESA From 1994-2000

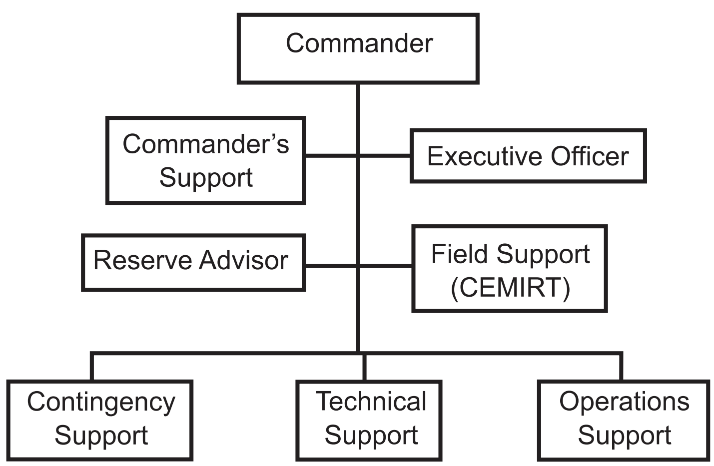
When Col. Paul W. Hains III returned to AFCESA to become Commander in July 1994, he pledged AFCESA's continued support to the major commands and base civil engineer organizations. Colonel Hains identified the following focus areas: customer satisfaction, open communication, integrity, and teamwork.[206]

Colonel Hains immediately began a review of AFCESA's organizational structure and products in light of on-going personnel reductions. AFCESA had shrunk from 303 authorizations in 1993 to 254 the following year and was projected to shrink to 210 in FY96. "Agency Relook" was a bottom-up review designed to implement total quality management concepts to ensure that tools and products were focused on the customer. The agency was examined by staff within the organization and by outside customers in the major commands and the bases to identify and rank core products and services. The bottom-up review identified the following focus areas for AFCESA:

- Provide tools/assistance to bases
- Provide centralized direction on computers
- Provide technical "how to" guides and standards in clear text
- Maintain readiness
- Focal point for training and educational
- Objective squadron enhancements
- Advocate vehicles/equipment
- Centralized/matrixed technical support
- Contracting center of expertise
- Specialty teams
- Customer awareness.[207]

With this information, a new organizational structure was formulated and submitted for approval to General McCarthy. He approved the new organizational structure in October 1994 and the implementation occurred in January 1995 (Figure 5.4). Under the new structure, AFCESA was organized into three directorates under the Commander: Contingency Support, Technical Support, and Operations Support. CEMIRT was placed in a separate office named Field Support under the Commander.[208] The Commander was supported by staff that included Air National Guard and Air Force Reserves advisors, professional communications, financial management, quality improvement, personnel, communications-computers, and information management. The AFCESA historian and the *Air Force Civil Engineer* Magazine were part of professional communications.[209]

Figure 5.4 AFCESA Organizational Chart, 1995



Source: Dr. Ronald B. Hartzer, "AFCESA Takes New Structure, New Direction," The CE, Vol 2, No 8, Winter 1995, 14.

A new mission statement for AFCESA also was unveiled: "Providing the best tools, products, and professional support to maximize Air Force civil engineer capabilities in base and contingency operations." The main product areas were training; management practices; technical consultation; computer support; vehicles and equipment; readiness capability; and research, development, and acquisition.[210] Colonel Hains outlined AFCESA's efforts for 1995 as focused on increased outsourcing of civil engineer support services, modernizing automation, developing contingency force structures for RED HORSE and Prime BEEF, Readiness Challenge V, and modernizing fire protection equipment. The result, he wrote, was to "focus on delivering needed tools to our base engineers, i.e., a better trained warrior, handbooks, training aids [using computer applications], technical evaluations, and improved readiness capability."[211]

Between May 1995 and August 1996, AFCESA was commanded by Col. Peter K. Kloeber. Colonel Kloeber came to AFCESA with experience as an exterior powerline electrician working in the base shops and as an officer with extensive experience as a base civil engineer. Colonel Kloeber continued to focus AFCESA on serving the bases through enhanced communications, such as A-Grams, to distribute technical information. Other accomplishments during this time were preparing model statements of work to support base-level contracting efforts, approving the new Automated Civil Engineer System (ACES) as the follow-on to WIMS, modernizing technical training methods using CD-ROM technology, and commissioning environmentally friendly fire training facilities. Colonel Kloeber also oversaw the renovation of the AFCESA Headquarters building at Tyndall AFB, Florida, and the creation of the AFCESA Board of Advisors.[212]

In 1999, AFCESA played a key role in developing and publishing the first minimum standards for building construction incorporating passive antiterrorism/force protection. The standards were signed on December 16, 1999 by the Under Secretary of Defense for Installations. The published standards applied to MILCON construction beginning in FY02 and beyond. AFCESA also was given the lead by the JCS Security Engineering Working Group to develop standards for existing buildings, family housing, and Non-Appropriated Fund buildings.[213]

In 1999, AFCESA won its eighth Air Force Organizational Excellence Award. The award was presented for the period January 1, 1995 through December 31, 1996 and recognized AFCESA's "unparalleled professionalism and technical expertise…to civil engineering everywhere."[214] By the end of 2000, AFCESA was staffed by 199 employees out of a total personnel authorization of 202. Of the authorized positions, 92 were military and 110 were civilians. AFCESA's workforce was augmented by 60 contractors.[215]

Development and Use of AFCAP

In 1996, the Air Force tasked AFCESA to establish the Air Force Contract Augmentation Program (AFCAP). AFCESA researched and designed the contract vehicle, and, once the contract was in place, AFCESA administered the overall contract and its individual task orders. AFCAP was based on the Army's Logistics Civil Augmentation Program and the Navy's Construction Capabilities Contract. AFCAP was a contracting vehicle to access private sector contractor support to relieve and/or to augment Air Force civil engineer activities during deployments for MOOTW situations in non-combat environments. Mr. Joseph Smith (CMSgt Ret), then working as a civilian employee at AFCESA, was assigned to a team to develop AFCAP. While the purpose of AFCAP was to augment Air Force civil engineer forces, many military personnel in the organization initially viewed the program as another way to downsize civil engineer numbers. However, General McCarthy stated that initial force beddown would always be done by blue-suit civil engineers. AFCAP requirements were drafted in 1996 and reviewed through the major commands.[216] AFCAP was written for flexibility and was designed to secure private sector contract support under the following conditions: for sustaining operations and maintenance after initial Air Force civil engineer field and beddown activities were completed, for recovering base infrastructure following attack or natural disaster, for remediating land returned to a host nation, and for reconstituting and repacking war reserve materiel kits, such as Harvest Falcon. AFCAP was designed to augment all Air Force civil engineer capabilities except for crash/fire/rescue and EOD, both of which were considered inherently governmental, and all Services capabilities except for mortuary and field exchange.[217]

In February 1997, AFCAP was awarded as a one-year cost plus fee contract with four, one-year renewal options to Readiness Management Support, L.C. (RMS), a joint venture between Johnson

Controls and Lockheed Martin. The contract vehicle was structured to allow major commands to fund task orders as part of overseas deployments or in response to natural disasters. The upper limit of the indefinite quantities contract was $450 million.[218]

Use of AFCAP as a contracting vehicle began slowly with little activity between 1997 and 1998.[219] Two task orders were issued under AFCAP during the first year (February 1997-February 1998) and six task orders were issued during contract year two.[220] PACAF issued the first task order through AFCAP to clean up Andersen AFB in Guam following Super Typhoon Paka in December 1997. Initially, PACAF mobilized military and civilian Air Force personnel across the command to provide disaster relief. PACAF personnel were augmented by Air Force personnel from Air Staff, ACC, CEMIRT from Travis AFB, California, and the 49th Materiel Maintenance Group from Holloman AFB, New Mexico. Private sector contractors were used for the cleanup effort to reduce the operations tempo on military and civilian employees during the holiday season. In the initial days following the disaster, private sector personnel were accessed through AFCAP, SABER, and housing and service contracts to repair facilities, clear debris, and restore operations.[221] Originally estimated at $750,000, the overall cost of the recovery rose to $2 million.[222] A second task order issued in 1997 developed an AFCAP concept of operations to inform Air Force personnel on the conditions appropriate for using AFCAP and procedures for activating the program.[223]

During the second contract year (February 1998-February 1999), six task orders were issued through AFCAP for a total of $2.3 million.[224] One AFCAP contract was used to clean up Keesler AFB, Mississippi, following Hurricane George in September 1998. AFCAP contractors worked at the base for six weeks to restore power to family housing, repair roofs, clear storm drains, remove debris, conduct damage assessments, and provide cost estimates for permanent repairs to facilities, housing, and runway lighting systems.[225]

Between 1999 and 2001, the use of AFCAP grew and $120 million of the contract capacity was reached.[226] In 1999, 16 task orders were processed through AFCAP for a total of $73.7 million.[227] AFCAP task orders in 1999 included staffing air traffic control positions at Langley AFB, Virginia, and Holloman AFB, New Mexico; constructing offices for the Customs Services at Aruba in the Netherlands' Antilles; repairing an airfield at Manta AB, Ecuador; and, designing a retention center for the Immigration and Naturalization Service at Grand Island, Nebraska.[228]

The majority of task orders activated through AFCAP in 1999 were associated with the U.S. intervention in Kosovo under Operation Allied Force, Joint Task Force Shining Hope, and Operation Sustain Hope. USAFE activated AFCAP to provide support for Operation Noble Anvil, to set up a tent camp in Hungary, to move building parts from Germany to Tuzla to house the Predator, to procure 26 pieces of heavy equipment for use at Balikesir, Turkey, and to operate and sustain the tent city constructed at Aviano AB, Italy. The largest task order issued under AFCAP was for building a Kosavar refugee camp near Fier, Albania.[229] AFCAP contractors established a good working relationship with the USAFE staff in the command center at Ramstein AB, Germany, and were incorporated into the planning process to support the mission.[230]

On August 17, 1999, a 7.4 magnitude earthquake rocked Turkey. Following the earthquake, the United States pledged relief aid. As part of that effort, AFCESA activated AFCAP to supply 390 tents, as well as power generators, latrines, and water bladders for the earthquake victims. The AFCAP contractor RMS, L.C. arranged shipment of the items to Turkey. Most of the equipment was already stored in the region and had been previously moved there to support construction of the Kosovo refugee camps.[231]

One of the larger efforts contracted through AFCAP was to supply the Kosovar people with wood building products to reroof 10,000 concrete-block homes before the winter of 1999-2000. USAID's Office of Foreign Disaster Assistance contacted AFCESA for support in a crisis situation. Thirty thousand tons of lumber were required in Kosovo within 30 days. The agency had been unsuccessful in securing lumber through established sources. AFCAP contractor RMS, L.C., utilized Bechtel

National, Inc., to mobilize its worldwide supply network. Seven mills in five countries, including Austria, Germany, and the Czech Republic, milled the lumber and shipped it to Skopje, Macedonia. From there, the lumber was moved to Pristina, Kosovo, and then distributed to 10 centers. The last lumber load was delivered in December 1999.[232]

During 2000, 11 task orders were issued through AFCAP for a total amount of $5.9 million.[233] Task orders for the Office of Foreign Disaster Assistance included inspection of supplies warehoused in Italy and Gibraltar and purchase of a variety of emergency disaster relief supplies, including boats, motors, water purification systems, water storage tanks, plastic sheeting, personal medical kits, blankets, and water bladders. The Office of Foreign Disaster Assistance activated AFCAP in response to typhoon flooding in Bangladesh and during recovery from Hurricane Keith in Belize and the Yucatan peninsula in Mexico in October 2000. Additionally, ACC tasked AFCAP to recruit 35 power production specialists for SWA. The power production specialists were assigned to four bases in SWA and augmented the pool of personnel available to serve, thereby reducing the number of military personnel required for rotational deployments. ACC also contracted through AFCAP for overall civil engineer base operating support and construction of temporary facilities, a parking lot, and an aircraft arresting barrier in Curacao, Netherlands Antilles. Another task order was to install polyester protective film on Air Force living quarters at Manta AB, Ecuador.[234] At the end of four years, over $85 million or 19 percent of the $452 million contract ceiling was expended.[235]

AFCEE – Its Establishment and Development

General Ahearn, The Civil Engineer between 1989 and 1992, placed particular emphasis on a total quality environmental program to bring Air Force operations into compliance with Federal environmental laws, to clean up past pollution, and to reduce hazardous waste to prevent future problems.[236] Prior to 1989, a general perception pervaded the Air Force that AFESC was responsible for environmental cleanup; this was not the case. At one time, the Air Staff included an environmental directorate while the field-level and installation restoration programs were assigned to AFESC. The entire program subsequently was moved to Headquarters in Washington, D.C. Although the environics researchers at the Engineering and Services Laboratory conducted a large number of research and demonstration projects in the field, specific base environmental cleanup was assigned to the major commands.[237]

During 1990, General Ahearn, along with Lt. Gen. Joseph Viccellio, Jr., Air Force Deputy Chief of Staff for Logistics and Engineering, and General McCarthy, began to transform the Air Force environmental program. The group developed and then led a series of environmental leadership courses at Tyndall AFB, Florida, that reached 150 major command, wing, and base-level senior leaders. The courses provided Air Force leaders with information on a variety of topics, including the environmental regulatory process, hazardous waste sites and their restoration, reduction of hazardous waste usage in base operations, natural resources programs, legal issues regarding personal liability, manpower and funding resources, and public affairs. The goal of the courses in General Ahearn's view was to "green" the Air Force leadership and to provide a common basis of information for leaders to deal with environmental issues.[238]

General Ahearn tasked then Deputy Director of Engineering and Services Brig. Gen. James E. McCarthy to oversee the environmental program by incorporating measurable performance goals. Monthly performance reviews were held and notices of violations were tracked. A cross-functional program management team was formed with senior Air Force representation that met monthly to examine environmental issues across the entire Air Force. In addition, working relationships with EPA and local environmental regulators were strengthened. In addition, the Air Force also sought to strengthen relations with the "new" partners in the environmental program—the public.[239]

General McCarthy made a major change in the overall management of the Air Force environmental program. As General McCarthy reported,

> I decided that we could not run the program with environmentalists and scientists, that we needed to run the program with line officers who were goal oriented, could communicate, and could get things done. Earlier we had entrusted the environmental program to the scientists, biologists, and the industrial hygienists. They were technically competent, but they were not program managers that could establish objectives, apply resources, measure progress, and oversee it.[240]

General McCarthy structured the environmental program after reviewing the requirements contained in the laws, regulations, and rules of the regulatory agencies. He assessed the current status of the Air Force environmental program and set priorities. The next step was to plan, gain support, and leadership attention for funding, training, and procedural changes. General McCarthy continued,

> We established schedules and goals and measured our progress. For example, we set a goal of getting rid of the thousands of underground storage tanks around the Air Force by a certain date. To execute the program, we established a fund stream within the MCP [military construction program], so that bases wouldn't have to use their operating accounts. We measured progress and sent out report cards to the leaders of major commands. That attracted leadership attention, and outstanding performance was the result. We also invested in education and training—our Masters of Engineering Management degree program at AFIT was refocused to "environmental management" [Graduate Engineering and Environmental Management Program], and our technical training for Airmen was changed to include applicable environmental features.[241]

The environmental program had four pillars. *Cleanup* dealt with the restoration of contaminated sites resulting from past actions. *Compliance* ensured that current operations were undertaken in accordance with contemporary standards. *Conservation* emphasized stewardship of natural and cultural resources and protection of endangered species. *Pollution Prevention* ensured that current decision making, principally during the acquisition process, did not create future environmental problems. General McCarthy assigned a top-performing officer to each pillar and held them accountable for success. The Air Force was singled out by the Office of the President for the Federal environmental program due to the success of this program.[242]

On April 17, 1991, General McPeak issued an environmental quality memorandum to all major commands. The memorandum mandated that Air Force personnel must accomplish environmental protection immediately and be responsible for the safe and efficient use of scarce resources to meet the Air Force mission. The memorandum established goals to complete 100 percent cleanup of hazardous waste sites by 2000; to achieve total compliance with Federal, state, and local environmental laws with zero notices of violation as the measure of merit; to prevent future pollution; and, to incorporate environmental impact analysis in support of decision making and protecting the environment. Protection and enhancement of natural resources, historic properties, and endangered species also were goals.[243]

Air Force Chief of Staff General McPeak was a strong proponent of the Air Force environmental program. General McCarthy described General McPeak as an environmentalist of the highest order who strongly supported environmental cleanup and pollution prevention. As an example, General McCarthy told the following story,

> [General McPeak] called me one day in the Air Staff and said, "Jim, this is General McPeak. Are we using environmentally benign de-icing chemicals on airplanes and runways?" I said, "No, sir." And he said, "Well, stop using them." I said, "Yes, sir." We used two alcohol de-icing fluids on airplanes, isopropyl alcohol and ethylene glycol. One of them was very harmful to the environment, and we had tons of it. The

other had a high biochemical oxygen demand but was not toxic. We got into it with the logistics community and built a plan to very quickly phase out the toxic chemical. That's just one example of his involvement, but he did those things out of the blue. And he didn't want long, qualified answers—just action. Everybody said, "You can't stop using our deicing chemicals instantly." I said, "He didn't mean to instantly stop using them, but he sure wants a plan and a commitment to move out smartly."[244]

The impetus for the establishment of AFCEE was in the tough questions posed by General McPeak during the intense March 1991 briefing on the functions of the Office of The Civil Engineer. During that briefing, General McPeak identified that the environmental program was not getting sufficient focus.[245] By the second briefing in May 1991, a separate FOA was proposed to provide a complete package of technical services related to environmental compliance, hazardous waste cleanup, pollution prevention, and construction and design management.[246]

Mr. J.B. Cole of the Senior Executive Service was working as deputy director for construction within the office of The Civil Engineer in 1991. Cole was credited with the initial idea of AFCEE. He proposed to then Brig. Gen. James McCarthy that a design and construction organization be located in Dallas, Texas. General McCarthy responded, "You have a good idea but the wrong location." General McCarthy went on to say that the new organization needed to comprise not only design and construction, but also environmental management, and the correct location was Brooks AFB, Texas. Mr. Cole worked in Washington, D.C., to build support and to organize the fledgling organization and was surprised and grateful when General Ahearn selected him to lead it.[247]

General McPeak was credited with naming the Air Force Center for Environmental Excellence (AFCEE). As General McCarthy recalled,

Mr. J.B. Cole, AFCEE's first Director.

> We were sitting around his office one day talking about AFCEE, the new agency we created to assist with execution of environmental programs. Bud Ahearn had asked me to be his point man for standing up the organization, and we were briefing General McPeak on it. We all had suggestions for naming the new organization. General McPeak said, "We're talking about excellence. I think we'll call it the Air Force Center for Environmental Excellence." And that was it.[248]

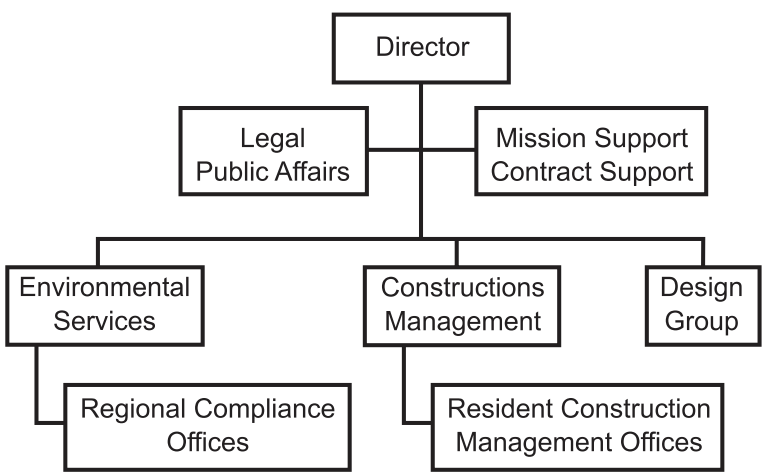
AFCEE was approved on July 5, 1991 and activated on July 23, 1991 at Brooks AFB, Texas. AFCEE's manpower authorizations were drawn from AFCESA, the AFRCE-BMS at Norton AFB, California; the Construction Management Office of the AFRCE in Dallas, Texas; contracting personnel from the Human Systems Division, AFSC, at Brooks AFB, Texas; other Air Force civil engineering positions in Washington, D.C.; and 40 bioenvironmental engineers from the Brooks AFB Support Branch.[249]

The new organization was introduced formally on November 3, 1991 in Hangar 9 at Kelly AFB, Texas.[250] The missions of the new organization included:

- Environmental cleanup management throughout the Air Force;
- Cleanup of bases closed under the Base Realignment and Closure Act (BRAC);
- Design assistance as the "Architect of the Air Force" to complement the Systems Engineering function at AFCESA;
- Construction management support for the smaller Air Force major commands; and
- Offering environmental and comprehensive planning support through three regional offices in San Francisco, California; Dallas, Texas; and Atlanta, Georgia.[251]

The structure of AFCEE, as proposed in May 1991, comprised two directorates: Environmental Services and Construction Management. Under Environmental Services were the offices of Cleanup, Environmental Impact Analysis, Prevention, and Regional Compliance. Under Construction Management were the offices of Design and Construction, Medical Facilities, Space, Reserve, and Environmental compliance.[252] However, the Design Group was soon broken out as a separate office. Design and construction services assigned to AFCEE supported smaller commands in the Air Force.[253] The main office was supported by three regional compliance offices, later renamed regional environmental offices at Atlanta, Georgia; Dallas, Texas; and, San Francisco, California. Regional

Figure 5.5 AFCEE Organizational Chart, 1991



Source: Maj. Gen. Joseph A. Ahearn, "Civil Engineer Reorganization Briefing," May-June 1991, AFCEC History Office.

offices offered the advantage of a single Air Force point of contact to interface with environmental regulators for all bases in a region. Initial staffing was proposed at 167 military and civilian personnel (Figure 5.5).[254] The first Director of the Construction Management Directorate was Col. Robert "Bob" Morris and the first Director of the Environmental Services Directorate was Col. Joe Saenz.[255] The Design Group was headed by Mr. Gary Lynn.

AFCEE began its first year with a small number of personnel located in borrowed office space dispersed throughout Brooks AFB. During its first year, AFCEE managed 350 projects worth $1.4 billion despite its small size.[256] By March 1992, the number of AFCEE employees reached 200.[257] By the end of 1992, $340 million in projects were under contract, while an additional $800 million were obligated for projects during 1993. The majority of the project awards were issued under indefinite delivery/indefinite quantity contracts; task orders were issued under these vehicles as needs arose. Contracting support was provided by 70 personnel working through the Human Systems Center at Brooks AFB, Texas. By December 1993, AFCEE was staffed by 450 persons. Some funding for staff came from the Defense Environmental Restoration Fund and BRAC.[258]

From its beginnings, the leadership of AFCEE focused on delivery of quality products to serve Air Force major commands and installations in their time frames.[259] Environmental compliance with NEPA for closed bases and remediation of hazardous areas on active bases were major priorities during the early 1990s.[260] AFCEE developed the Installation Restoration Program Information Management System to store, manage, and retrieve data on soil and water samples collected at thousands of Air Force sites.[261]

One important aspect of AFCEE's work was dissemination of environmental information to support base activities through many types of media. Between 1992 and 2004, AFCEE hosted the Air Force Pollution Prevention Conference, later called the Joint Services Environmental Management Conference. The conference was combined with the National Defense Industrial Association's Environmental and Energy Conference in 2004.[262] AFCEE also maintained an information clearinghouse on environmental and research issues known as PRO-ACT. PRO-ACT was established in October 1992 by Lt. Col. Kent Rohlof and his deputy Tom Russell in the Pollution Prevention Division. PRO-ACT's mission was to "provide timely and accurate answers to customer questions and disseminate environmental information throughout the Air Force." In its first year, PRO-ACT answered about 2,000 technical inquiries; by 2001, 12,000 inquiries were answered.[263] In 1992, AFCEE began to publish a magazine entitled *CenterViews.* The magazine typically contained an introduction by the director and articles on AFCEE projects and personnel.

AFCEE also supported major commands bases with design and construction. AFCEE fielded planning assistance teams, architectural assistance teams, and interior design assistance teams. Gary Lynn, a former deputy of the AFRCE in Dallas, Texas, became the Director of the AFCEE Design Group. Lynn recalled an early assignment to assist the Air Mobility Command to design a building to consolidate the command's operations and aircraft maintenance units. A team was sent to the major command and a design, a study model, and a presentation briefing were prepared in just two weeks. The design became a prototype for command facilities.[264]

AFCEE was assigned the management of Air Force Design and Construction Awards. These yearly awards, begun in 1976, promoted design excellence throughout the Air Force. Management of the awards competition transferred from the Air Staff to AFCEE in 1991, when AFCEE was established. The contest comprised three awards: Air Force Agent, Air Force Design Excellence, and Air Force Design Awards Program. Entries were submitted by the bases through the major commands and the competition awarded three levels of awards: Honor, Merit, and Citation. Before 1991, jurors of the competition were selected from the private sector. After 1991, jurors were selected from both the private sector and government design professionals for the Air Force, DoD, General Services Administration, or the Veterans Administration. "We look at the program as being a lot more than a way to pat ourselves on the back for what a great job we've done. We think of it as a viable tool we can use to promote excellence in the Air Force. It has become a measuring stick to measure our successes," said Mr. Dave Duncan, Senior Architect at AFCEE and manager of the Air Force Design Awards Program between 1992 and 2006.[265]

In December 1993, Mr. J.B. Cole, who led AFCEE for two years, retired from the Air Force. He recalled those rewarding formative years at AFCEE as long, hard work days by dedicated staff. Cole summarized the achievements of the first two years of AFCEE's operation as follows:

- Established credibility of Air Force environmental program to include prevention, minimization, restoration and reclamation.
- Established beneficial relationships with EPA regulators.
- Built customer confidence among Air Force bases that used AFCEE services.
- Worked with the research community to find better and more effective ways to clean up sites.[266]

In December 1993, Col. Thomas W. Gorges became the new AFCEE Director and its only military director. Colonel Gorges foresaw the continued role of AFCEE in the environmental and social aspects of base closures, environmental remediation, and pollution prevention. During 1994, the organizational structure of AFCEE expanded to include the following directorates: Construction Management, Design Group, Environmental Conservation and Planning, Environmental Restoration, and Pollution Prevention. AFCEE also gained a new assignment overseeing the family housing construction program. During 1994, the family housing program amounted to approximately $350 million.[267] Contracts awarded for environmental cleanup in 1994 topped $1.24 billion. The contracts covered full-service environmental remediation nationwide and 16 specific AFBs.[268]

The AFCEE emblem was designed during 1994 by Rich Perry. The shield contained a compass to represent AFCEE's design and construction functions and an eagle to represent AFCEE's commitment to protecting the environment. These symbols are placed over a blue sky and a yellow sun to represent the sphere of Air Force operations. A wreath of laurel leaves symbolized the dedicated personnel who work at AFCEE.[269]

Air Force Center for Environmental Excellence emblem

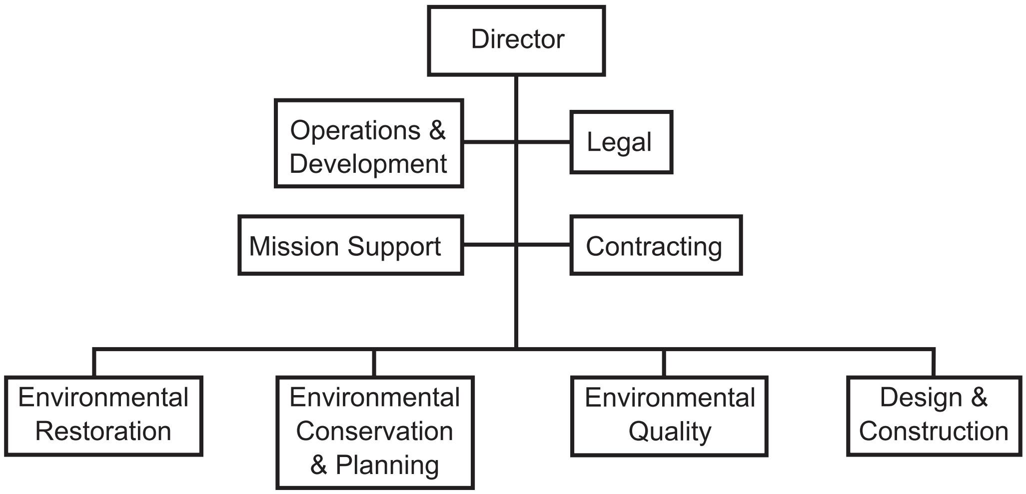
View of the Air Force Center for Environmental Excellence, Brooks AFB, Texas, 1996.

Ground was broken on July 13, 1994 for the construction of a new permanent headquarters building for AFCEE at Brooks AFB, Texas. The new building consolidated office space from six different locations and several modular buildings. The building was designed by Cromwell Architects-Engineers of Little Rock, Arkansas, and Kinneson and Associates, San Antonio, Texas. The building was completed in August 1995.[270]

Colonel Gorges served as AFCEE Director until his retirement in May 1995. Tony Zugay served as interim director for a year.[271] In May 1996, Mr. Gary Erickson, Senior Executive Service, became Director of AFCEE, coming from the Missouri River Division of the U.S. Army Corps of Engineers at Omaha, Nebraska. AFCEE now offered a full line of environmental services, and its role in construction and design expanded to include architectural and planning services for Air Force installations worldwide. AFCEE also provided construction management for MILCON projects, for medical facilities, and for the Air Force Reserve, as well as served as the design and construction agent for military family housing, non-appropriated fund and operations and maintenance projects, and the Energy Conservation Investment program.[272]

In 1997, AFCEE was streamlined. The Pollution Prevention Directorate was renamed the Environmental Quality Directorate. The name change signaled a philosophical shift to treat installations as systems where pollution prevention and cleanup were integrated. As more base-level measures for pollution prevention were implemented, fewer future environmental compliance issues were anticipated. The former Construction Management and Design Group directorates were merged into the Design and Construction Directorate (Figure 5.6). This merger was the result of decreasing MILCON budgets and the transfer of those activities to major commands. The Design and Construction Directorate retained responsibility for medical construction and provided agent services for family military housing when requested by major commands. In addition, the new directorate was challenged to investigate "green construction" and to analyze the building acquisition and construction process to minimize impacts on the environment. The other directorates within AFCEE were unchanged. Three regional environmental offices continued to serve their designated roles, but added the function of serving as DoD Regional Environmental Coordinators in their respective regions. In this new role, the regional environmental offices spoke as the representative for all Services with regional EPA regulators.[273]

Figure 5.6 AFCEE Organizational Chart, 1999



Source: "AFCEE Organizational Chart," 1999, AFCEC History Office.

In 1998, AFCEE was designated to oversee the Air Force family housing privatization program. Other duties included supporting environmental issues on Air Force range areas and the formation of a Technology Transfer Division. The new division studied and field tested new technologies to improve environmental cleanup activities. By 2001, AFCEE controlled over $1 billion in funds, of which $436 million supported environmental restoration. The organization was staffed by 50 military personnel and 360 civilians.[274]

MANAGING THE PEACETIME BASES

Introduction

Military and civilian personnel reductions brought about by rapidly changing world events precipitated a radical reorganization of the base civil engineer squadron (CES), known as the Civil Engineer Objective Squadron. Also, Air Base Operability (ABO), Disaster Preparedness (DP), and Explosive Ordnance Disposal (EOD) personnel were realigned under the civil engineer umbrella. These offices typically were already present at the bases; their offices typically reported directly to the base commander or as part of other units.[275]

The limits prescribed for CES manpower led to the adoption and implementation of efficient and streamlined management processes following contemporary business models, multi-skilling of military and civilian shop personnel, zonal maintenance, and adopting improved automated systems. In addition, civil engineer personnel and functions were augmented through outsourcing, contracting, and privatization. These strategies became increasingly important options to assure base operation and maintenance in accordance with exacting Air Force quality standards. The civil engineer organizations continued to meet environmental requirements and to implement energy conservation measures.

During the early 1990s, budgets decreased dramatically. As military construction funding declined, efforts were made to secure Operations and Maintenance (O&M) funding to modernize buildings and infrastructure. Aggressive programs to consolidate, to dispose of, or to inactivate unneeded facilities also were pursued. These programs included demolition of unneeded facilities, as well as base closure.

Civil Engineer Objective Squadron Reorganization

During 1993, General McCarthy and the major command civil engineers approved the Air Force Manpower Standards to convert the CES to the objective squadron model. As finally approved, the new squadron structure comprised nine flights: Commander, Housing, Resources, Engineering, Environmental, Fire Protection, Explosive Ordnance Disposal, Readiness (formerly Airbase Operability), and Operations. The flight name change from Airbase Operability to Readiness reflected a broader concept of total contingency support that incorporated training, organizing, and equipping the CES to keep the air base functioning in emergency situations.[276]

Staffing for the civil engineer objective squadron initially was set at 269, but was increased to 283 to include personnel in EOD, ABO, and DP functions. This total included 8 officers, 144 enlisted, and 131 civilians.[277] The standardized staffing applied to all squadrons at installations in the operational commands in ACC, AMC, ATC, USAFE, and Pacific Air Forces.[278] Flexibility in staffing was allowed for smaller and larger-sized bases and to meet mission requirements. The manpower standard did not apply to contractor-operated bases.[279]

As described in Air Force Pamphlet 32-1005, "the objective squadron was formed to improve job accomplishment and centralize the work of the mission. The objective was to reduce unnecessary and redundant supervisory positions, multi-craft and multi-skill the workforce, and implement better, business-like practices to the process associated with work accomplishment."[280] The broader responsibilities for each technician were commensurate with the types of assignments encountered by Airmen during deployment.

Personnel allocations were thoroughly studied by the Air Staff, AFCESA, and the major commands. The process of calculating final staffing numbers focused on streamlining processes to achieve the most efficient operations and eliminating duplicate efforts. The implementation of the civil engineer objective squadron allocated the reduced personnel available to operate and to maintain each base into a new organizational structure. Two other efforts vital to accomplishing the civil engineer objective squadron were multi-skilling of crafts personnel and implementation of zonal maintenance.[281]

Multi-skilling

Under multi-skilling, craftsman training was expanded to enable Airmen to perform more than one trade. The shops employed personnel classified in one of 17 Air Force Specialty Codes (AFSC). Under the implementation of the civil engineer objective squadron, and as part of civil engineering's response to DMRD 967, the number of AFSCs was reduced to 11. Chief master sergeants from the major commands were consulted and provided valuable insights on how to multi-skill shop personnel.[282] The chiefs recognized that merging AFSCs, if done with deliberate thought, could and would result in every enlisted civil engineer attending in-residence technical training. Before multi-skilling was implemented by the civil engineers, all AFSCs (AF-wide, not just civil engineer AFSCs) were divided into one of three "categories," depending on complexity, difficulty, and length of training required to obtain initial proficiency. The most technically challenging and difficult AFSCs (i.e. exterior powerline electrician and refrigeration/air conditioning) were category A; all accessions in this category attended in-residence tech school to obtain a three-level prior to their first CE squadron duty assignment. Category B AFSCs were specialties of intermediate complexity (i.e. plumber, carpenter, and interior electrician); half of accessions attended tech school and half were assigned as "direct duty" from AF Basic Training. Those assigned direct duty were expected to attain a three-level through On-the-Job Training (OJT). Category C AFSCs were specialties of least complexity (Civil Engineering had none by the early 1990s); all accessions were assigned as direct duty and expected to attain three-level by OJT.[283]

The Chiefs' Council experience and connectivity to the enlisted force paid off for civil engineering, and ultimately, the Air Force. The chiefs immediately deduced if two or more AFSCs were merged, the resultant "category" would always be an A, if at least one of the AFSCs prior to merging was an A, eliminating the question of why certain folks in Category B went to tech school and others did not. That question was squarely on the mind of most CE senior NCOs when the Chiefs' Council met to formulate recommended mergers. The outcome was correctly predicted; all merged Civil Engineering AFSCs became category A. For example, interior (Category B) and exterior electrician (Category A) merged to become a Category A "electrician." Civil Engineering's merger was so successful that it became a vanguard of Air Force reorganization at the time. General McPeak instituted "mandatory tech-school" for all AFSCs; a concept of operation still in use today.

The technicians in the merged AFSCs were required to acquire additional skills. Merged AFCSs included:

- Interior electricians and exterior powerline electricians were merged under Electrical;
- Heating, controls and refrigeration technicians were merged under Heating, Ventilation, Air Conditioning/Refrigeration;
- Carpenters and sheet metal technicians were merged under Structural;
- Pavements technicians were merged with equipment operators under Pavements and Equipment; and,
- Plumbing technicians were merged with environmental support under Utilities Systems.

The skills of engineering assistant, power production, liquid fuels, pest management, and fire protection were not affected by multi-skilling.[284] The reorganization of the shop personnel eliminated foremen positions in each shop specialty and shifted the focus of the shops to completing projects, rather than working within trade specialties.[285]

The adjustments to the shop organization on the bases often reflected practices in the private sector. For example, heating, air conditioning, and controls skill sets were blended in the private sector. On individual bases, heating and air conditioning were divided into two different shops, each with its own foremen, work facilities, and support equipment. The most difficult AFSCs to merge were interior and exterior electricians. Multi-skilling this group presented significant safety challenges to overcome since interior involved work with low voltage electricity and exterior work was with high voltage electricity.[286]

Initially, multi-skilling was resisted at the base level since it represented a radical departure from the previous system. The enlisted force was uncomfortable with expanded responsibilities since promotions were tied to skill areas. Civilian employees saw a reduction in the number of supervisory positions. Some senior NCOs were challenged by the transition from technician to supervising a workforce representing several technical skills. General McCarthy stated "I viewed multi-skilling as essential for our survival as a viable organization. Our manpower had been so reduced that we wouldn't be viable unless we shed our 'union' cards and did what was best for the Air Force. Status quo was not an option."[287]

Multi-skilling was required for military personnel, but was voluntary for civilians. Beginning on July 1, 1993, 10 bases experimented with introducing multi-skilling for civilian workers in the areas of heating, ventilation, air conditioning, and controls; carpentry and sheet metal; and, pavement and equipment operations.[288] Multi-skilling for civilians was implemented for CONUS bases shortly thereafter.

The implementation of multi-skilling required an aggressive training program in the multi-skilled technical fields. Technical training was accomplished in one of three ways: formal training through Air Training Command, CerTest, or career development courses. Initially career development courses were the preferred training method, but the numbers accommodated in the courses were approximately one-third of the number of personnel requiring additional training.[289] CerTest was a computer-based training program designed to certify, test, and evaluate a candidate's knowledge of principles and procedures. The program incorporated videotapes and computer-based learning modules.[290] By 1995, a formal set of Career Field Education and Training Plans for each multi-skilled specialty was distributed to the field. Still concerns over multi-skilling arose.

During 1994, AFCESA conducted an assessment on the status of multi-skilling throughout the Air Force civil engineer organization. AFCESA used a combination of questionnaires and personal interviews to collect data. After analysis, the data and recommendations were presented to The Civil Engineer, General Lupia. The data revealed that training was insufficient to make multi-skilling successful. After reviewing the data, General Lupia set the target date of January 1, 1998 for completion of training on all core tasks for all personnel in multi-skilled AFSCs.[291]

Zonal Maintenance

The zonal maintenance concept was adopted Air Force wide in 1992. Under this concept, a base was divided into geographical zones that were serviced by a single team of multi-skilled technicians who primarily conducted minor maintenance and repair activities and an occasional larger-scope project. Most major repairs and large-scope projects were completed either in-house by a heavy repair team that had horizontal (pavements, equipment, and grounds) and vertical (structural, plumbing, and electrical) construction capabilities or contracted out. Utility repairs were conducted by a dedicated utilities team.[292] These teams were also able to "bid" on large construction projects and execute them with a multi-craft team which was more similar to the way projects were completed during contingencies.

One advantage of this system was that multi-skilled teams were able to inspect each facility within their geographical zone every 30 to 90 days to keep abreast with maintenance tasks, minor repair, and special tasks. The teams were familiar with the facilities within their zone of operation, and facility managers established working relationships with civil engineer zone leaders and knew who to contact with work order requests.[293] One disadvantage of the new system was the limited training opportunities for technicians assigned to routine or simple tasks within a single geographical area. Complex tasks that posed potential training opportunities were assigned to specialized teams. According to General McCarthy, "I left it up to the MAJCOMs to implement the zonal maintenance concept, because I concluded that it was short-lived and the commands who employed the concept would decide for themselves that it was untenable. And we saw bases establish four zones in year one and then consolidate zones each year until the concept disappeared."[294]

The debate continued about whether to retain the zonal maintenance concept or return to the shop system to improve training during General Lupia's tenure as The Civil Engineer. At the end of 1997, General Lupia tasked AFCESA to conduct a study of the Operations Flights and its sub-layer of elements in the CES to assess the effectiveness of the organization. The study also reviewed training requirements, vehicles, equipment, facilities, and manpower and personnel actions.[295]

AFCESA developed a 200-question questionnaire, which was submitted to all major installations. Responses were received from 65 installations, 55 of which were in the United States and 10 of which were overseas. All Operations Flights that responded to the questionnaire were organized in accordance with the five element model: Maintenance Engineering, Material Acquisition, Heavy Repair, Facility Maintenance, and Infrastructure. Variety in the organization appeared below the element level. Respondents to the questionnaire revealed that 25 percent of the installations were organized by zones. Another 25 percent were organized into centralized shops. Fifty percent of the installations were organized into a hybrid that combined the two systems. Bases operating both in zones and in shops were pleased with their performance results. The overwhelming response to the question of "If you could select any organizational structure, which one and why?" was a clear preference for a hybrid organization. AFCESA then held a workshop to review the data gathered through the questionnaires; small groups examined the issues surrounding the Operations Flight organization. The meeting reached broad consensus that organizational flexibility was a key element to success on the base level. The centralized shop with multi-skilled personnel was not effective, nor was one type of organization suitable for every installation; commanders preferred flexibility in organization. Based on these results, revisions were drafted to AFI 32-1031, *Operations Management*, to allow organizational flexibility below the flight level, to establish roles and responsibilities for Operations Flight commanders, to improve clarity of element work responsibilities, and to refine workflow requirements procedures.[296]

Emergency Services

During the 1990s, emergency services under the civil engineer organization were expanded with the addition of EOD and DP personnel. Firefighters had been assigned to the CES since the establishment of the Air Force in 1947. Firefighting responsibilities included aircraft crash and rescue operations, as well as fighting fires on base. EOD and DP received greater emphasis as part of the base civil engineer organization and became increasingly important in deployment situations.

Fire Protection

Firefighters typically were the base's first responders to accidents and to fires involving aircraft along the flightline, as well as fires that occurred on base. Firefighters continually were on call and in readiness whenever aircraft were in the air. On-going training was required to hone emergency skills, and equipment continually was upgraded to keep pace with technologies.

In August 1993, Air Force installations began receipt of the P-23 crash fire truck to replace the P-2. This new vehicle weighed more than 78,000 pounds and had a top speed of 72 miles per hour. It was able to dispense 3,800 gallons of water and foam firefighting agents from the roof turret and bumper turrets at faster rates that the older P-2 model.[297]

Training for Air Force firefighters also was improved. Crash fire rescue training facilities were standardized at each installation and comprised "an aircraft mock-up, a burn area, control stand, liquid propane fuel system, cathodic protection system and water conservation pond." Environmental concerns over the fire burn pits had nearly shut them down across the Air Force in the 1990s. The pits used JP-4 and JP-8 as fuel and Aqueous Film-Forming Foam to extinguish the fires, both of which affected the air and groundwater near the pits. Beginning in 1992, an environmentally sensitive fire pit using liquid propane gas was designed and construction began at 87 pits across the Air Force.[298]

An Air Force firefighter assigned to the 28th CES, Ellsworth AFB, South Dakota, uses a P-23 Aircraft Rescue and Fire Fighting Vehicle to extinguish a mock fire during a Major Accident Response Exercise.

Not only were firefighting vehicles and training upgraded, but also a new design for base fire stations was adopted. In 1996, newly constructed Fire Station No. 1 at McConnell AFB, Kansas, was designated as the "model" fire station for the Air Force. The 26,500-square foot facility incorporated a wide range of functional and quality of life improvements. The physical design represented several design iterations. Initially, the fire station at the former SAC base was designed with seven drive-through fire vehicle stalls and two-person bunkrooms. The two-person bunkroom was an improvement over the open bay bunkrooms of earlier stations. When McConnell AFB transferred to AMC, Brig. Gen. Eugene A. Lupia, AMC Director of Civil Engineering, directed that the bunk area of the building be redesigned to contain single rooms with closets, the same requirements incorporated into the modernized Air Force dormitory standard. Other modern features included in the design of the fire station were an emergency response room with fully computerized communications control console, administrative suite, conference room , physical training room, training classroom, CerTest computer room, a full kitchen, modern heating and ventilation system, and a fire protection sprinkler system.[299]

During 1998, a bottom up review of the Air Force crash/fire rescue program was conducted through AFCESA and independent analysts. Col. H. Dean Bartel, AFCESA commander from 1996 to 1999, explained the significance of the review:

> it represented the first time I can recall that we ever went back and took apart the crash fire rescue business, brick by brick, to see what our standards really ought to be. There are several sets of standards. FAA [Federal Aviation Administration] has a set of standards. The National Fire Protection Association (NFPA) has a set of standards. Then the Air Force standard was above and beyond that. Our standards have always been higher. So there was an effort to try to settle on what the standards should be when you balance things like cost effectiveness, operational risk, and so forth, and see what we should really have. We ended up taking NFPA standards and adopting them as our crash fire rescue standards, which paid off in that we were able to go to a national standard that's recognized.[300]

The new Air Force standard retained the three-person rescue team, but incorporated the potential for future manpower savings. Manpower savings were linked to the acquisition of new fire vehicles with advanced technology.[301]

Throughout the decade, Air Force firefighters experienced pressure to downsize their operations. In some cases, base firefighting units relied on nearby communities for backup services during base emergencies. Conversely, base firefighters provided support to local communities. For example, firefighters from Tinker AFB joined civilian crews in responding to the bombing of the Murrah building in 1995 in Oklahoma City, Oklahoma.[302] On August 18, 1998, firefighters in the 22d CES at McConnell AFB, Kansas, assisted the city of Wichita in decontaminating entry crews and potential victims following a suspected Anthrax exposure. The crew erected tents, showers, and containment equipment to confine the possible threat. Tests later revealed that the suspected material was not anthrax.[303]

An annual award for the year's most outstanding Air Force Fire Protection Flight was established at the Air Force level in 1994. The award began as a SAC award, but after the dissolution of SAC in 1992, the office of The Civil Engineer presented the award. The award was named for CMSgt. Ralph E. Sanborn, a long-time fire chief at SAC who began his career in World War II and had a 44-year career in Air Force Fire Protection.[304] The Air Force also presented "Firefighter of the Year" awards to one military and one civilian.[305]

A firefighter from Tinker AFB, Oklahoma, surveys the damage at the Alfred P. Murrah Federal Building in downtown Oklahoma City.

Disaster Preparedness

Established in 1965, Disaster Preparedness (DP) was a branch of base operations reporting directly to the base commander.[306] In 1991, DP personnel joined the civil engineer organization. When the civil engineer objective squadron was implemented, DP personnel were organized within the ABO Flight, later renamed the Readiness Flight. The DP personnel were charged with developing base-level plans for "preparation, response and recovery" from nuclear, biological, and chemical (NBC) attacks.[307] Base-level chemical biological (CB) defense programs comprised three phases: assessment, deployment, and employment. The assessment and deployment phases were considered "pre-attack actions" and included reconnaissance of the area and training procedures. Plans were formulated that defined tasks and schedules for completion. Tasks included establishing a CB detection, warning, and reporting system, as well as creating command and control facilities for a Survival Recovery Center, a Nuclear, Biological, and Chemical Control Center, and a Damage Control Center. Other measures of a plan included camouflage, concealment, and deception.[308] The employment phase was the active response to an attack and included avoidance, protection and contamination control—the three tenets of CB defense.[309] The DP teams also assisted in civil matters; contingencies for natural disasters and accidents involving hazardous materials (HAZMAT) were included in DP plans.

New training requirements for all first responders were implemented during the early 1990s. All DP personnel were required to train and to certify all security and medical personnel in HAZMAT procedures. A formal DP training program was conducted at Lowry AFB, Colorado. When Lowry AFB closed in 1994, the DP Resource Center's duties were moved to AFCESA and the DP technical training was moved to Fort McClellan, Alabama. DP technical training was relocated to Fort Leonard Wood, Missouri, in 1998.[310]

Until the end of 1995, the Readiness Flight included DP and Force Managers. On November 1, 1995, these two AFSCs were merged. The DP responsibilities were expanded to include management of installation Prime BEEF teams, including assigning, equipping, training, and supporting mobilization and deployment of teams. These duties were executed in addition to those normally assigned to disaster preparedness specialists, such as camouflage, concealment and deception, NBC, shelter operations, and contamination control. The new specialty also was responsible for planning for natural and manmade disasters and major accidents.[311]

An annual award for the year's most outstanding Readiness Flight was established as the Col. Frederick J. Riemer Award. The award was created in 1994 to honor the service of Colonel Riemer, who was the first Air Force officer in the disaster preparedness career field and was the first to be promoted to full colonel.[312]

Force Protection

While this concept was implemented in military contingency situations, Force Protection (FP) declined in importance on overseas bases after the end of the Cold War and was at minimal levels on domestic Air Force installations. The Khobar Towers bombing in 1996 prompted the U.S. military to reassess its standing defensive posture on overseas bases and to re-emphasize the importance of the force protection concept. The 1995 Oklahoma City bombing of a Federal government building also brought security concerns to CONUS air bases. A renewed emphasis on FP emerged in the Air Force culture. Force Protection extended to all personnel and resources necessary to execute the installation mission. Civil engineers, EOD, and disaster preparedness personnel were essential to implementing passive protection measures along with security and intelligence personnel. This renewed emphasis on FP was codified in Air Force Doctrine 2-4.1 entitled *Force Protection* published in 1999.[313]

Facilities Management

Throughout the 1990s, Air Force civil engineer worked to improve efficient functioning of base facilities. Base facilities were assessed for satisfactory performance, upgraded, or disposed of, as necessary.

Commanders Facility Assessments

To maintain existing facilities in a state of mission readiness, The Civil Engineer office requested additional Operations and Maintenance (O&M) funding throughout the 1990s. The request for additional funding was based on a Commander's Facility Assessment completed at each installation. The process of briefing the major commands on the assessment occurred in early 1993, and the results were submitted to AFCESA for compilation in August 1993.[314] All facilities were evaluated on their condition and ability to meet mission requirements. Three rankings were possible: unsatisfactory, degraded, or satisfactory.[315] At AFMC, the facilities rating system was structured into nine common systems, each with sub-components. Each system was analyzed based on standard criteria from maintenance and repair publications. These standards were applied throughout the major command and teams of civil engineer crafts and engineering personnel conducted the inspections. The inspection results were compiled and combined with the mission requirements rating to complete the Commander's Facility Assessment for each installation.[316]

The Commander's Facility Assessment for 1993 revealed that 70 percent of the Air Force facilities on bases were rated as satisfactory. Eight percent were deemed unsatisfactory and programmed for upgrades within the next two years. The remaining 22 percent were classified as degraded and funds to upgrade those facilities were programmed for a two-to-six year time frame. The results of the Commander's Facility Assessments were incorporated into the Program Objectives Memorandum (POM) for FY96-FY01 budgets.[317] The request for the real property maintenance account was increased by $1,452 million.[318]

Air Mobility Command's Facility Excellence Program

One of the Air Force's newest major commands, Air Mobility Command, made a major effort toward improving its facilities in the 1990s. Brig. Gen. (later-Maj. Gen.) Eugene A. Lupia, the command's first Civil Engineer, recognized the problem, "MAC [Military Airlift Command] guys just never spent a dime on facilities. They didn't believe in it; they didn't think it was important, and they just let them continue to run down." Shortly after his arrival at AMC, he learned that was going to change. Even before Gen. Ronald R. Fogleman became AMC Commander in August 1992, he met with General Lupia and told him that he wanted to improve AMC's appearance. In his first few weeks at AMC, General Fogleman took General Lupia on a two-week whirlwind tour of the command's bases and documented what needed to be done. AMC soon put out a series of design guides under the Commander's Guide to Facility Excellence program. Echoing General Wilbur Creech's sentiment, General Fogleman explained, "Our Air Mobility Command installations must provide pleasant and efficient environments within which to conduct mission support, and to attract, motivate, and retain highly skilled and dedicated people.… Installation excellence does not cost—it pays!!" Within a few years and using BRAC funding, the command transformed itself.[319]

Demolition of Excess Structures

Demolition of unneeded facilities on bases was a method to consolidate and to reduce excess square footage, and thereby save on future operations and maintenance costs. Between 1988 and 1994, the Air Force demolished over 7 million square feet of excess space. In 1994, the Air Force had identified an additional 8 million square feet for demolition. Demolition costs were projected at $81.7 million and offset by future savings in O&M costs. Since funding for demolition was limited, the Air Force proposed legislation to authorize the Secretary of the Air Force to reprogram MILCON funding to cover facility demolitions.[320]

The OSD issued Defense Reform Initiative Directive (DRID) #36 entitled Disposal/Demolition of Excess Structures as part of a 1998 Defense Reform Initiatives program. This directive recognized that the Armed Services had 80 million excess square feet in over 8,000 structures. DRID #36 directed that funding be increased to remove excess structures. The Air Force was tasked with demolishing 14.9 million square feet by FY03.[321] Interim goals for meeting this target were pursued aggressively between 1997 and 2003. By the end of the second quarter of FY03, the Air Force met 96 percent of its target.[322]

Environmental Programs

Throughout the 1990s, the Air Force embraced tougher legislative requirements for pollution prevention and installation cleanup. The Installation Restoration Program (IRP) continued to make progress in environmental remediation; 835 of the 4,354 identified IRP sites were restored by 1992.[323] Eglin AFB, Florida, was the subject of a comprehensive IRP that began in 1981. More than 50 sites were identified; many were old landfills containing petroleum contaminants and hazardous waste, including Agent Orange. The Air Force continued an in-depth IRP throughout the 1990s, while monitoring the contaminated sites. The Air Force's goal during the 1990s was to have an IRP in progress at all installations by 2000.[324]

The Air Force Environmental Awareness Program, begun in the early 1990s, challenged every civil engineer to understand the environmental impacts related to their job and to reduce the use of hazardous and waste materials.[325] Across the Air Force, base personnel actively sought ways to limit environmental impacts in day-to-day base operations. The Plastic Reclaimable Abrasive Machine (PRAM) was used at several installations, negating use of hazardous chemicals in stripping paint from aircraft tire rims. Prior to the advent of PRAM, tire rims were soaked in paint stripper for 2-3 days. The process was hazardous and personnel wore rubber suits, respirators, and underwent periodic blood tests to ensure their safety. Maintenance shops accumulated approximately one 50-gallon drum of hazardous waste each month. The PRAM has a high pressure hose that spit out tiny plastic beads at 40 psi and stripped paint in a matter of minutes, thus reducing hazardous waste, increasing efficiency, and eliminating safety concerns.[326]

Closing the Circle Awards

In 1993, the Office of the Federal Environmental Executive established the White House Closing the Circle (CTC) awards. The award sought to recognize Federal employees and agencies that did an outstanding job operating and implementing environmental programs. Award categories included: waste/pollution prevention, recycling, environmental management systems, sustainable design/green buildings, and green purchasing.[327]

McClellan AFB in California received the CTC award in 1998 for its hazardous waste prevention efforts. The extensive program dated from 1985 when McClellan AFB established the first Environmental Management directorate in DoD. The environmental program included projects for recycling concrete from demolitions, incorporating the use of more electric vehicles, reducing and eliminating hazardous waste, and soil remediation, among others. Soil remediation efforts included soil vapor extraction (SVE) treatment units and multiphase extraction system. The SVE extracted "volatilized contaminants for treatment" while the multi-phase system "extracted both contaminated soil vapor and contaminated groundwater from the subsurface" for treatment.[328]

Brooks AFB, Texas, and Wright-Patterson AFB, Ohio, also won Closing the Circle Awards in 1998. Brooks AFB won for its role in the Texas Pollution-Prevention Partnership formed in 1996. Wright-Patterson AFB won an award for its radioactive material recovery and recycling program. The Air Force Academy in Colorado received an honorable mention for minimizing its hazardous waste through recycling.[329]

The Pollution Prevention Act of 1990 created a policy aimed at the prevention or reduction of pollution rather than the control of its after-effects. By the mid-1990s, the Air Force had implemented its own policies, directives, and instructions regarding pollution. Every installation was required to implement a Management Action Plan (MAP) addressing pollution prevention by December 1995.[330] Air Force Directive 32-70, *Environmental Quality*, and Air Force Instruction 32-7080, *Pollution Prevention Programs*, institutionalized the Pollution Prevention Act and enforced the MAP. As part of AFI 32-7080, the Air Force required every installation to perform a Pollution Prevention Opportunity Assessment (P2OA) on a routine basis. The P2OA assessed all pollution and waste at the installation and identified ways to achieve its reduction or elimination. Results of the P2OA were required in the Pollution Prevention Management Action Plan.[331] The plans also included management approaches to reduce "ozone depleting chemicals, the EPA 17 industrial toxics, hazardous wastes, municipal solid waste, affirmative procurement of environmental friendly products, energy conservation, and air and water pollutant reduction."[332]

In June 1995, DoD and Russian Ministry of Defense signed a memorandum of understanding on environmental protection cooperation. The cooperative agreement continued throughout the 1990s and provided for multiple visits between countries to exchange information on environmental protection activities including waste disposal, military site cleanup, and disposal of weapons. General Lupia led the delegation in Moscow in January 1998.[333] USAFE personnel were also involved in the environmental aspect of the Partnership for Peace Program by helping Eastern European countries manage environmental compliance and restoration programs and bring their countries into compliance with European environmental standards.

Along the same lines of promoting environmental awareness across the Air Force, General Lupia also initiated an educational program for civilian leaders to see firsthand the progress being made across the Air Force on environmental issues. General Lupia would accompany a group of about 40 civic leaders, defense industry executives, and engineering and environmental leaders on tours and briefings at key Air Force installations on a three-day trip.[334]

The Air Force encouraged individual bases to improve the relationship between neighboring communities and the base. The Joint Land Use Study (JLUS), which began in 1985, received greater attention in the 1990s on Air Force bases. By 1990, 17 bases were participating in the program. This was paying dividends through increased community awareness of Air Force concerns into local comprehensive planning efforts. In February 1990, Headquarters USAF/LEE requested major commands "to provide written commitment of support from commanders at bases participating" in JLUS.[335]

During the 1990s, the Air Force managed a robust program to identify, to evaluate and to nominate buildings, sites, structures, objects, and districts to the National Register of Historic Places in accordance with the National Historic Preservation Act of 1966, as amended, and its implementing regulations. Air Force Instruction 32-7065: *Cultural Resources Management* was issued on June 13, 1994 to implement DoD Directive 4710.1: *Archaeological and Historic Resources Management* dated June 21, 1984.[336] By 1995, the Air Force managed approximately 1,600 historic properties listed on the National Register of Historic Places.[337] Some historic properties included Maxwell AFB, Alabama, senior officer quarters; Midvale Archeological Site in Arizona; Burro Flats painted cave in California; Hickam Field, Hawaii; Base Administration Building at Randolph AFB, Texas; and, Pope AFB historic district, North Carolina. The Air Force, under the direction of ACC, also began a multi-year program to develop historic contexts as the basis for identifying and evaluating built resources associated with the Cold War era. Two Cold War-era properties listed in the National Register of Historic Places were the space launch complex at Vandenberg AFB, California, and Cape Canaveral Air Force Station, Florida.[338] On September 27, 1995, the Air Force became the first regulated Federal agency to sign a proclamation with seven government and civilian agencies to preserve Air Force historic buildings and properties. The proclamation recognized the need for the Air Force to meet its mission requirements and quality of life while balancing responsibilities and the costs of preserving historic buildings under Air Force stewardship.[339] The Air Force also began to complete cultural resources management plans to integrate stewardship of cultural and historic resources into base operations. DoD recognized several Air Force historic resources programs throughout the decade. Edwards AFB, California was among several DoD bases commended for its archeological research and protection program. DoD also commended Wright-Patterson AFB, Ohio, among other bases, for the management of historic buildings. Both F.E. Warren AFB, Wyoming, and Vandenberg AFB, California, were honored for overall cultural resources management strategies.[340] In 1999, Vandenberg AFB received the Cultural Resources Management Installation Award. Vandenberg AFB established a particularly successful working relationship with the Chumash Indians, negotiating access for "hunting, fishing, plant collecting, and sacred ceremonial activities."[341]

Energy Programs

During the 1990s, energy conservation programs were reinvigorated. New initiatives were needed, as Col. Marshall W. Nay, Jr. wrote in 1992,

> We are going to get serious about both energy conservation and energy efficiency again—not due to shortages but because of our budget…we're going to focus on conventional energy sources and, through the enlistment of smart business practices and empowerment of the user community, we'll make progressive and incremental improvements.[342]

Areas identified for improvement included, but were not limited to, HVAC systems; landscaping; housing occupancy; and, lighting. Emphasis on energy conservation increased during the mid-1990s in anticipation of the FY00 deadline for 20 percent energy reductions set in 1985. The Air Force Facility Energy Plan was revised during the early 1990s to adopt the 10 strategies identified by DoD for reducing energy consumption. One strategy sought to apply "recycling, recovery and reclamation" for HVAC/R equipment.[343] Federal legislation during the period also mandated additional energy reductions, including the Energy Policy Act of 1992. This act authorized Energy Savings Performance Contracts (ESPCs). Through ESPCs, Federal agencies could retain contractors, who "financed, designed, implemented, and could possibly operate, maintain, and own infrastructure modifications."[344] In 1994, the first Air Force ESPC was awarded to Johnson Controls to retrofit 114,500 lights at Randolph AFB, Texas. The same year, Hill AFB, Utah, issued an ESPC for base-wide modifications to the HVAC and lighting systems. Subsequent Executive Orders 12902 and 13123 increased the target for energy reduction to 30 percent.[345]

In August 1995, AFCESA became responsible for Facility Energy and Water Conservation Programs. As the responsible agent, AFCESA developed and implemented plans in conjunction with the Air Staff and major command civil engineers, as well as audited the program's progress.[346]

Advances in Automation

Improvement to automated systems and the development of databases continued to offer efficiencies in managing data and personnel for base level operations. On November 18, 1990, the Defense Management Report Decision (DMRD) 924 was approved by the Deputy Secretary of Defense. Entitled "Consolidate ADP Operations and Design Centers in DoD," DMRD 924 required all Armed Services to review their automated data processing systems, to make recommendations to consolidate and to realign systems to improve efficiencies, and to eliminate duplicate efforts in computer software systems and hardware purchases. A Software Design Activity working group met in early 1991. One of the group's recommendations was to continue the development of WIMS/SIMS software through AFCESA. By 1996, the WIMS/SIMS software was planned to migrate to a standard Air Force hardware platform. The continued design of the software packages was transferred from AFCESA to the Air Force Standard Systems Center by the end of FY95.[347]

The development of software programs for the WIMS platform continued. In 1991, a recurring work program software package for WIMS was nearing completion after two years of development. This package promised to be a dynamic and easily updated tool to track permanently deferred items and man-hours to support continuing work, as well as to prepare work schedules and to identify required tasks and man-hours linked to automated Air Force and local standards.[348] Additional programs in testing or in development under WIMS included a real property management package, a financial management package, and a project management system. Future additions to the WIMS software package included upgrades to the in-service work plan, weekly scheduling program, and work order systems.[349]

During 1991, software was under development to transfer data from BEAMS to WIMS. Real property records, which were managed using BEAMS, were planned for transfer to the WIMS format. Plans to phase out BEAMS were proposed during 1991. Five major commands were tasked to identify one lead base to begin the process.[350] These base selections were made by mid-1991. The BEAMS transition was, however, rescheduled due to a delay in converting the Civil Engineering Materiel Acquisition System (CEMAS) to the WIMS platform, which was undertaken by the Air Force Standard Systems Center.[351] By December 1991, CEMAS was undergoing tests at Wright-Patterson AFB with selected release of the software planned at installations in early 1992. BEAMS was scheduled for decommissioning on October 1, 1993.[352]

By 1995, the Systems Automation staff in AFCESA actively was working on the next generation of computer automation for civil engineering. The new system incorporated telecommunications local area networks (LAN) and wide area networks (WAN) connectivity and an improved information management system to allow worldwide use. LAN installations were completed at Air Staff, AFCESA, and Tyndall AFB, Florida; additional systems were installed at Moody AFB, Georgia, and Eglin AFB, Florida.[353]

During 1995-1996, Deputy Civil Engineer Dr. Robert Wolff, Senior Executive Service, chaired the Civil Engineer Automation Steering Group, formed to review the future automation needs of the organization. The steering committee released the Civil Engineer Automation Strategic Plan in 1996. The strategic plan provided guidance for improvements to civil engineering automation systems. One goal for the next generation of automation was to "transition the WIMS framework into a relational database linked to full graphical applications, supporting the full range of operational and contingency responsibilities. The envisioned system will be appropriately integrated and standardized to maintain Air Force uniformity, but allow major command/base flexibility."[354] This transition provided greater integration with other functional areas of the Air Force, such as logistics, contracting, personnel, and security, as well as provided information in a global environment. The new system was named the Automated Civil Engineer System or ACES.[355]

The WIMS systems were operated and maintained on Wang mini-computers accessed by personal computers, rather than "dumb" terminals as originally installed. WIMS provided a worldwide electronic mail communication system and a built-in office information system. However, the Wang system was proprietary in its software applications and hardware and was not readily adaptable to the rapidly changing technology. By 1996, the Air Force civil engineer organization was using both Wang mini-computers and Intel-based personal computers. The Intel-based personal computers ran a wide variety of commercially available software packages for word processing, spreadsheets, relational databases, and graphics programs, including Computer-Aided Design, and Geographic Information Systems. Electronic communications were conducted using modems over commercial lines connected to the Defense Information Network System. LANs and WANs were being installed to facilitate communications and data transfers.[356] By 1997, approximately 25 to 30 percent of the LANs were installed; installation of all networks was planned for FY98.[357]

The next phase of development was to transfer WIMS from the Wang to the open UNIX-based systems after LANs were installed. By summer 1996, UNIX-based WIMS were operational at Selfridge ANG Base, Michigan; Tyndall AFB, Florida; Homestead Air Force Reserve Base, Florida; Camp Murray, Washington; and, Moody AFB, Georgia. The CES at Tyndall AFB was the first to inactivate the Wang system.[358] In October 1998, the Air Force Standards Systems Group at Maxwell AFB-Gunter Annex and AFCESA announced that the Air Force civil engineer organization worldwide had completed the transfer from Wang mini-computers to a regionally operated, UNIX-based system known as the Interim Work Information Management System (IWIMS).[359]

The next goal was to develop a relational database management system to replace WIMS and transfer the data to ACES. Prototype testing of the new ACES also was planned. Both steps were planned for FY98.[360] In May 1999, ACES version 1.0 was installed at the Air Education and Training Command at Randolph AFB, Texas.[361]

Outsourcing and Privatization

The Air Force adopted outsourcing and privatization at an increasing rate throughout the 1990s. These initiatives offered attractive methods to augment base civil engineer services and personnel in an era of reductions in military and civilian personnel and restricted budgets. The U.S. Congress, the Executive Branch, and DoD promulgated policies and initiatives to encourage the Armed Services to adopt outsourcing and privatization as best business practices.

One recommendation of the 1993 National Performance Review entitled "Creating a Government That Works Better and Costs Less" was for DoD to institute a program of contracting non-core activities through the competitive bidding process. Outsourcing architectural design services and construction management activities functions were recommended to both the U.S. Army Corps of Engineers and the Naval Facilities Command. An additional recommendation developed during the review was to empower Air Force customers to select the district or field office that handled their construction work.[362]

On November 30, 1995, Chief of Staff of the Air Force, General Ronald R. Fogleman, sent a letter to all major command commanders stating that transferring in-house activities to commercial contractors was one way to improve quality and to reduce costs. General Fogleman announced the establishment in October 1995 of an Outsourcing and Privatization Division in the Office of The Civil Engineer. To accomplish General Fogleman's directive, the major commands also established outsourcing and privatization offices.[363] Each commander was directed to report plans for increased contracting in their FY98 Program Objective Memorandum submission.[364] The Air Force Commercial Activities Program managed the overall program for outsourcing of Air Force functions. The tension between retaining military manpower and increased contracting for Air Force civil engineer activities was a challenge throughout the 1990s.

Outsourcing and the A-76 Process

Outsourcing was defined by the government as "transferring the performance of a function previously accomplished in-house to an outside provider," also known as contracting work out.[365] The Office of Management and Budget (OMB) published the first version of OMB Circular A-76 in 1966. This circular was developed to "discourage the Federal government from being in direct competition with private industry for goods and services."[366] As revised over the years, the A-76 process required DoD and other Federal agencies to conduct managed competitions to compare costs for performing activities using in-house personnel and resources with private sector commercial firms. The first step in the process was to complete a review of all Air Force activities to determine which core functions were to remain in-house to meet war readiness requirements, critical skills, or national security concerns, versus those activities classified as non-core functions. By 1997, the review was completed and a publication was prepared identifying civil engineer activities available for cost comparisons and those that were not due to readiness reasons.[367]

The A-76 process was "a competitive sourcing process whereby the Air Force determines the most efficient way to provide support services by cost-comparing the use of in-house staff versus private contractors."[368] The goal of the A-76 process was to employ competition to ensure efficient operations and to drive down operations costs.[369] The advantage of the process to the Air Force was the ability to focus military personnel on core military missions and readiness capabilities.[370]

AFCESA provided support to guide bases throughout the process, including setting up a help desk in August 1998. The A-76 process was not new to DoD. Prior to the late 1990s, cost comparisons had been applied to small functions. Cost comparisons to determine the most efficient organization were now being required between in-house personnel and commercial firms to operate major functions within civil engineering, such as entire squadron flights on the bases, and even entire civil engineer squadrons.[371]

In 1998, the Air Force initiated 255 ongoing cost comparison competitions for over 16,000 non-military essential positions. An additional 41,000 positions were subject to cost comparison under program Jump Start, a four-year program extending from FY99 through FY02. A total of 9,600 civil engineer positions underwent cost comparisons to meet Air Force targets. Cost comparison was defined as "the approved process for determining the most cost effective means of performing commercial activities."[372] Cost comparison competitions were projected to achieve a 25 percent reduction in operating costs. Under a cost comparison, positions occupied by military personnel were either contracted out to the winning bidder or converted to civilian slots, in cases where "in-house most effective organizations" were determined to be economically advantageous. The A-76 outsourcing competitions extending through 1998 revealed that in-house most efficient organizations won the cost competitions 40 percent of the time.[373]

During 1996, AFMC began an intense examination of the cost effectiveness of contracting out the majority of civil engineering and environmental management functions under the A-76 process. Two bases, Arnold AFB, Tennessee, and Los Angeles AFB, California, already were operated by contractors.[374] During 1997, AFMC examined the potential for applying the A-76 process to operations at 10 bases.[375]

By 1998, 19 Air Force bases were involved in outsourcing competitions. In one example, a group of bases located near Colorado Springs, Colorado, issued a competitive consolidated waste management contract for the group.[376] At MacDill AFB, Florida, the CES was converted in November 1999 to a contractor operation following an A-76 competition. The A-76 study at Kirtland AFB, New Mexico, began in December 1998 and resulted in contracting base operations in July 2000. Lessons learned from these A-76 competitions found that projections for long-term savings typically were optimistic, that adjusting to changing mission priorities was problematic without increased contractor costs, and that base management contracts became required funding items in an installation's budget.[377]

Privatization

Privatization was defined as "transferring control of a target activity and its associated assets to an outside provider, characterized by the shift of responsibility to this provider for the fundamental, long-term financial investment required to sustain the privatized activity."[378] During the late 1990s, privatization initiatives were begun for military family housing and utilities. The privatization potential for unaccompanied personnel housing also was under discussion.

Housing Privatization

The FY96 National Defense Authorization Act established the Military Housing Privatization Initiative. The initiative allowed DoD to establish long-term land leases for private sector entities and for these entities to obtain private financing for the construction or improvement of military family housing, third-party financing and privatization efforts. The legislation enabled the private sector to construct, renovate, operate and maintain housing in the United States and its Territories while the Air Force focused its attention on meeting the installation mission.[379] In 1998, AFCEE was tasked by The Civil Engineer to act as the service agent to oversee housing privatization efforts.[380] Further impetus to privatize family housing came from the Defense Planning Guidance of FY99 that set the goal to revitalize or replace all DoD family housing units that were in "poor to adequate condition" by 2010. With MILCON projects for housing projected at $250 million per year, the funding was not available to meet that target date. Privatization of family housing became the tool to meet that goal.[381]

The Air Force's first project was initiated at Lackland Air Force Base, Texas in August 1998. AETC at Randolph AFB requested proposals to "design, construct, finance, own, operate, maintain, and manage" 420 new rental units at Lackland AFB.[382] The project entailed the construction of 148 new units and the replacement of 272 existing units. The terms of the project provided for land lease to the developer, a direct loan for $10.6 million, and a guarantee against changes in the base status that would result in a shortage of military renters.[383] The privatization project at Lackland AFB was part of the Air Force program to modernize or replace one-third of its current inventory.[384]

By 1998, family housing privatization projects were under study at Robins AFB, Georgia; Elmendorf AFB, Alaska; Dyess AFB, Texas; Mountain Home AFB, Idaho; Kirtland AFB, New Mexico; and, Peterson AFB, Colorado.[385] By 2001, housing projects at Robins and Dyess AFBs were privatized.[386]

Utilities Privatization

Utility systems were also candidates for privatization. Military installations have often had difficulty obtaining funding for utility infrastructure modernization. This has sometimes had deadly consequences, such as the natural gas pipeline explosion at Ft Benjamin Harrison, Indiana.[387] An Executive Branch initiative to improve the efficiency of providing governmental services and the military's interest in maintaining utility systems at a high industry standard led OSD to request legislation for the authority to privatize utility systems at military installations. Subsequently OSD issued Defense Reform Initiative Directive (DRID) #9 dated December 10, 1997, and #49 issued December 23, 1998, both entitled "Privatizing Utility Systems." Under these reform initiatives, the Armed Services were instructed to develop plans to analyze all electric, water, wastewater, and natural gas utility systems for privatization, with the exception of specially exempted systems, by September 30, 2003. The major commands also had the option to privatize steam, hot water and chilled water generation systems. The Air Force was required to identify all systems available for privatization by September 30, 2000 and to issue all solicitations for privatization by September 30, 2001. The reform initiative applied to all active duty, guard, and reserve bases.[388]

As supported by OSD's DRIDs and supplemental guidance, privatization involved divestiture of the utility system by transferring title to the successful offeror, and concurrently contracting with the same successful offeror to provide service. These contracts for utilities services normally did not involve the utility commodity itself; the privatization contract was for service provided for the infrastructure, formerly owned by the Air Force. The term of the service contract was normally 50 years, while the transfer of title (by bill of sale) was in perpetuity; the infrastructure conveyed to the successful offeror would never be returned or revert to Air Force ownership. The contract would have to be renegotiated at the end of the 50-year term.[389]

One concern for the Air Force was the potential loss of expertise in operating and maintaining utility systems at deployed locations. In November 1998, Maj. Gen. Eugene A. Lupia, The Civil Engineer, and Colonel H. Dean Bartel, commander of AFCESA, briefed the Air Force Chief of Staff concerning the need to retain civil engineer readiness expertise on utility systems. Power and water treatment professionals were required to retain wartime readiness capabilities. General Lupia requested that 108 Air Force utility systems be exempted from privatization, mostly in the force projection commands of ACC, AMC, PACAF, and USAFE.[390]

In February 1999, the Air Force Chief of Staff informed the Civil Engineer community that the original goal of privatizing 251 utility systems over eight years had changed. The new goal was to "have all requests for proposals ready for solicitation NLT [no later than] 30 Sep 01, and all privatization actions must be complete by 30 Sep 03," for 463 systems, including 212 systems located on Air National Guard bases. AFCESA established a utilities privatization manager and added 20 additional contract employees to handle the increased work load.[391]

A phased approach to utilities privatization was adopted. The first phase was to analyze each of the Air Force's 501 utility systems to identify the systems available for privatization. This analysis was completed by AFCESA and the major commands. The deadline for identifying candidates for privatization was September 2000. The second phase was to develop requests for proposals. The third phase was the evaluation of proposals and selections of the successful contractors. The deadline for completing all utilities privatization was September 2003.[392]

Each major command was instructed to establish a point of contact for the program. Each individual base was instructed to appoint a central point of contact and to form a base integrated process team comprising members representing operations, real property, engineering, and environmental functions. This team also included members from contracting, legal, security, finance, civilian personnel, and public affairs. The integrated process team was responsible for reviewing the generic scope of work developed by AFCESA and tailoring it to fit installation requirements. The team also was responsible for gathering data, including real property records, cost data, projects, and updated utility maps, to support the scope of work. AFCESA reviewed all finalized scopes of works prior to advertisement. The process to privatize utilities was lengthy.[393]

In August 1998, AFCESA awarded a $3 million contract to analyze the privatization potential of 25 utility systems at seven bases in Texas: Lackland, Randolph, Brooks, Laughlin, Sheppard, Goodfellow, and Dyess.[394] In FY99, AFCESA awarded $30.1 million to analyze the privatization potential of 301 additional utility systems. The remaining 137 systems were scheduled for study in FY00. In April 1999, responsibility for privatizing 181 utility systems on Air National Guard bases was transferred to the Defense Energy Support Center.[395]

By 2000, 451 utility systems throughout the Air Force had been assessed for privatization potential. Three hundred seventy-two systems were selected for privatization, while 79 systems were exempted from privatization due to manpower readiness requirements. Reviews were outstanding for 59 systems out of a possible total of 501 utility systems by the September 30, 2000 deadline set for identifying all candidates for privatization. Three projects had progressed to phase two of the program. Three requests for proposals (RFP) to privatize utilities were issued in January 2000. One RFP was issued for the Texas Regional Demonstration project covering 25 utility systems at six AFBs and one Air National Guard base. RFPs also were issued for four utility systems at Maxwell AFB/Gunter Annex in Alabama, and one RFP was issued for Cape Canaveral Air Station, Florida, that covered water and wastewater systems. In March 2000, an RFP was issued to privatize wastewater, gas and electric systems at Bolling AFB, D.C. To guide bases through the competitive bidding process for utilities privatization, AFCESA prepared a template for RFPs that was easily tailored to base requirements.[396]

Base Closures - United States and Overseas

During the 1990s, the physical plant managed by Air Force civil engineers was reduced substantially both in CONUS and overseas. In CONUS, Public Law 101-510 entitled the Defense Base Closure and Realignment Act of 1990 established procedures for closing and realigning military bases. The U.S. Congress charged DoD with compiling a list of bases for closure and realignment and presenting the list for consideration to an independent Base Realignment and Closure (BRAC) Commission, whose members were nominated by the President and confirmed by the Senate. The commission then reviewed the DoD recommendations and prepared final recommendations. Final recommendations then were submitted to the U.S. President, who either sent the recommendations back to the commission for further deliberation or forwarded them to the Congress without change. The commission's recommendations went into effect unless the Congress disapproved by a joint resolution of both houses. The law required base closure and realignment actions from the 1988 closures to be completed by September 30, 1995 and actions from subsequent rounds to be wrapped up within six years of the date the President forwarded the proposals to Congress. Other actions such as property disposal and environmental work could extend beyond the six-year limit. AFCEE and the Air Force Base Disposal Agency were key players in this process. This was a multi-million dollar, high-profile, time-sensitive process to prepare environmental impact statements and real estate transactions to quickly transfer the closed installations.[397]

In 1990, the first Air Force base closings were in process based on recommendations from the 1988 BRAC commission. Bases subject to closure were George, Mather and Norton AFBs, California; Chanute AFB, Illinois; and, Pease AFB, New Hampshire.[398] Major commands were responsible for transferring military functions and equipment to other bases. Once that task was completed, the bases were turned over to the Air Force Base Disposal Agency, who provided a caretaker for each base until the base was turned over to the community. Pease AFB in New Hampshire was the first Air Force base to close in 1991; three bases were closed in 1992.[399]

Three BRAC commissions met during the 1990s: 1991, 1993, and 1995. The Air Force had 86 active and 21 reserve U.S. bases that met one requirement for consideration for closure. In 1991, 11 active bases and 2 reserve bases were selected for closure; one base was recommended for realignment and partial closure. In 1993, four active bases and one reserve base were selected for closure, and three other bases were realigned. Five bases were selected for closure in 1995.[400]

The BRAC legislation required official closure of the bases within six years after the recommendations were forwarded to the U.S. Congress, although property disposal and environmental cleanup was allowed to continue beyond that time frame. By September 30, 2001, the Air Force had completed the base closings and had a new basing structure comprising 60 major CONUS bases: 15 bases assigned to ACC, 13 to AETC, 10 to AFMC, 8 to AFSC, 2 to AFSOC, and 12 bases to AMC. The 60 major air bases did not include Headquarters, U.S. Air Force, D.C.; Bolling AFB, D.C.; U.S. Air Force Academy, Colorado; Eielson and Elmendorf AFBs in Alaska; or, Hickam AFB, Hawaii.[401] Approximately 20 major bases were assigned to the Air National Guard and Air Force Reserve.[402]

The funds to close bases and to realign Air Force functions were provided by specially designated BRAC funds. The Air Force civil engineers used the BRAC monies to invest heavily in new buildings and infrastructure on the bases that received new missions realigned from closing bases. General McCarthy recalled, "We not only funded new buildings to accommodate the added missions, we also used the BRAC money to upgrade the base infrastructure, including roads, utilities, recreational facilities, and housing. Some accused us of using BRAC funds to 'get well,' and there was some truth in that statement."[403]

The Air Force also reduced dramatically the number of overseas bases. In 1982, the Air Force had a total of 44 major overseas air bases. By 1997, six main operating bases remained in PACAF; two main operating bases were located in South Korea, three in Japan, and one on Guam. From a total of 16 main bases under USAFE, the number dropped to six bases dispersed in England, Germany, Italy, and Turkey.[404]

The oldest overseas airfield, Clark Air Base in the Philippines, was closed following a natural event. In June 1991, Mount Pinatubo erupted, leaving the 11,000-acre Clark AFB covered in 6-to-12 inches of volcanic debris and ash. This debris caused 111 buildings to collapse and damaged an additional 64 buildings. Rains following the eruption turned the ash and debris into mud, further damaging buildings. While more than 20,000 military and civilian personnel and dependent families and pets were evacuated from the base, 2,000 military personnel remained, including security police, civil engineers and services personnel, communications personnel, logisticians, medical support, selected command staff, and legal personnel to handle the salvage of military equipment and to pack and ship the household goods of evacuated military families. Civil engineering personnel assigned to Clark AFB worked closely with logistics teams to salvage building materials and equipment from the base. These efforts were assisted by personnel from the 554th RED HORSE squadron deployed from Osan AFB, Korea.[405] On November 26, 1991, Clark AFB, the largest Air Force overseas base in PACAF, was officially closed and the property was transferred to the Philippine Government.[406]

CONSTRUCTION PROGRAMS

CONUS Construction

Housing and Dormitories

The Air Force's emphasis on quality of life and improved living standards was obvious in the construction program undertaken during the 1990s. Both Air Force family housing and unaccompanied personnel housing were in need of considerable repairs. While privatization offered a way to renovate family housing units, as John B. Goodman, Deputy Under Secretary of Defense, noted, more than 60 percent of the approximately 400,000 unaccompanied housing units maintained by DoD required renovations at an estimated cost of $9 billion.[407] Along with affordable and improved housing, the Air Force pushed for new construction of commissaries, child care centers, and physical fitness centers.[408]

The National Defense Authorization Act for FY93 recommended that the Armed Services revise their design standards in addition to renovating existing dormitories.[409] In response, the Air Force proposed private rooms in 1993. Design standards for unaccompanied personnel housing were revised November 6, 1995 by Secretary of Defense William Perry. The new standards implemented the "1+1" configuration and replaced the 1983 "2+2" double occupancy standard. The standard design encompassed 118.4 square feet of living space per occupant and two separate quarters sharing a bath and kitchenette.[410] Scott AFB, Illinois became the first installation to construct the "1+1" dormitories in 1996.[411]

During the late 1990s, the Air Force developed several goals and plans to achieve better housing for personnel. Plans included the Dormitory Master Plan, Family Housing Master Plan, and Housing Management Strategic Plan. Each plan outlined housing and budgeting requirements to satisfy the housing deficits.[412] The family housing master plan outlined a process of combining MILCON funds with privatization to achieve the goal of having all 110,000 family houses in good condition by 2010.[413]

Air Force Vision 2020 put quality of life at the forefront of its program. Dormitory living would be phased into efficiency apartments by 2020; the program first sought to construct "1+1" rooms with walk-in closets for Airmen beginning in FY96.[414] The Air Force established its own goals for improving housing; by FY00 the Air Force wanted to "buy out permanent party central latrine dormitories" and build new facilities. The Air Force met its goal of buying out the central latrine dormitories in FY99. The Defense Planning Guidance of FY99 also set the goal to revitalize or replace housing that was in "poor to adequate condition."[415]

The 1996 housing program contained 34 projects to construct or renovate 2,147 units at a cost of $250 million while 30 percent of the FY96 MILCON budget was dedicated to the construction of dormitories. The following year, 48 projects were budgeted to construct 2,175 units and $111 million of the FY97 budget was allocated for construction or renovation of one dormitory at 14 bases.[416] In 1997, unaccompanied personnel housing was at a 14,000-room deficit. MILCON budgets and housing goals sought to remedy that deficit. The MILCON budget for FY99 allowed $119 million for 1,750 unaccompanied personnel housing units and $226 million for family housing. The money allotted for family housing would replace 784 units, construct 64 new units, and improve 625 units.[417] Military Family Housing (MFH) and Temporary Lodging Facilities (TLF) received large increases in funding and construction in FY95. The MFH program erected 174 new units, renovated 2,587 existing units.[418] Two years later, MFH expanded to include the construction of 70 new units and renovation of 1,837 existing units. The TLF program received 420 new units and renovated 302 units in 1997.[419]

The Office of The Civil Engineer made housing policy and issued technical direction to the major commands and installation commanders who, in turn, implemented the housing programs. Air Force housing policy guaranteed projects would meet DoD standards,

> For family housing, these criteria incorporate whole house standards which meet minimum square footages, contemporary housing features, and environmental and energy conservation attributes. For unaccompanied housing the essentials include room-bathroom configuration and minimum square footage commensurate with the occupant's grade.[420]

Whole house standards included individual rooms for specific functions: "living, dining, family, and laundry rooms" and "a patio or balcony with privacy screen."[421]

Special Projects: Space and Missile Program Support

Air Force civil engineers supported space and missile programs for the Air Force on both the east and west coasts of the United States. They managed significant construction projects in support of DoD's mission to assure continued entry into space. These programs thrust the civil engineer community into the fast-paced and ever-changing environment of advanced technology, integrating an even broader level of experience and complexity to the civil engineer mission.

The Eastern Range and the 45th Civil Engineer Squadron

The Air Force civil engineer community continued to contribute its expertise to the space and missile programs through the 1990s and into the 21st century. In particular, the 45th CES worked with contractors and the U.S. Army Corps of Engineers to support operations for the Eastern Range, an area that spanned approximately 4,000 miles between Cape Canaveral Air Station in Florida to Ascension Island in the South Atlantic Ocean. This range was utilized for launching DoD space vehicles in support of satellite orbits. During the early 1990s, civil engineers were involved in programs to rehabilitate and to build new facilities for space support. They also were engaged in initiatives to ensure environmental safety, including endangered species and wetlands, within the Eastern Range. The technological requirements for facilities and the environmental concerns made work on the Eastern Range particularly challenging.[422]

Many priorities were considered as a part of the large-scale mission to launch space vehicles into orbit. At Cape Canaveral Air Station, the 45th CES worked with contractor Johnson Controls World Services to ensure that facilities supporting the mission were up-to-date and that species and their habitats within the cape were protected. Two species were of particular concern. The cape was home to a substantial population of the endangered Florida Scrub Jay. Personnel implemented landscaping percentage requirements to sustain the population and its habitat. They also organized a monitoring system for the birds to assess movement and potential impacts to the population. The cape was also the location for a significant sea turtle nesting habitat. Adjustments to lighting and nighttime launch activities were made at the air station to accommodate the particular nesting habits of the turtle. In addition, the 45th CES implemented and monitored fire safety measures. These included clearing brush areas through controlled burns, while monitoring and accommodating species within the area.[423]

The civil engineers, along with Johnson Controls personnel, were responsible for the operations and maintenance of the launch facilities; they also provided logistics support and supervised construction. They were responsible for the buildings and structures at Cape Canaveral and 10 additional tracking sites within the state of Florida. During 1994, civil engineers provided support for a total of 36 launches. Their work included coordination with 11 tenants of Cape Canaveral, including NASA and the Navy Naval Ordnance Test Unit.[424]

The most stressful and challenging phase of the 45th CES's involvement with the Eastern Range was the 10-day time period leading up to a launch. Numerous systems checks were completed and last minute work orders were fulfilled. During a single launch, civil engineer personnel were responsible for the operation of as many as 90 cranes and 26 elevators. These machines were not only out-of-date, but also were deteriorated as a result of their continuous outdoor environment. This made operations even more difficult, but personnel persevered. The civil engineers, along with Johnson Controls staff, completed 100 assignments at Cape Canaveral Air Station and the 10 tracking annexes. The total value of projects completed during 1994 was over $17 million.[425]

The 45th CES also supervised an ambitious O&M and MILCON construction effort during the 1990s. Up until this point, many facilities associated with the Eastern Range were maintained adequately to fulfill DoD space launching mission. The 1994 construction program involved modernizing the facilities of the downrange area. The downrange facilities included Antigua Air Station (AAS) and Ascension Auxiliary Airfield (AAA). Both locations incorporated the equipment necessary to support launch activities. These included "telemetry systems, radar, command and control, meteorological equipment, and missile impact location systems." In addition, both sites accommodated permanent and temporary personnel, and therefore required on-base necessities such as housing, recreation, food services, and laundry facilities.[426]

The AAS, located in the northeast area of Antigua, encompassed 472 acres of land. The operational sites comprised one main base location and eight dispersed electronic tracking facilities. The station was under the ownership of the government of Antigua. Construction at AAS during this period included an 18,000 square-foot, $8 million Consolidated Instrumentation Facility (CIF). The facility replaced outdated machinery and offered a modern tracking system to support "communications, timing, radar, range safety and telemetry." A new reserve power plant was also constructed for the CIF.[427]

The AAA was located on remote British territory. The Air Force facility on the island comprised 3,856 acres, with a main base location, an airfield, and 11 electronic tracking facilities. The AAA also required the installation of a modern CIF. The new CIF encompassed 21,500 square feet and cost an estimated $11.9 million. Construction on a $22 million Power/Desalinization Plant at AAA also began during this time.[428]

In addition to the MILCON activities at AAS and AAA, another 33 projects worth approximately $15.5 million were being planned or were under construction. These projects included the construction of modern maintenance shops, as well as rehabilitation and repairs to housing and food services facilities. The ambitious improvements and construction projects at AAS and AAA illustrated the importance of maintaining advanced technological resources to support DoD's continued presence in space. The 45th CES's management of the construction of these facilities enhanced the role of the civil engineer as a leading contributor to modern technological advancements.[429]

Vandenberg Air Force Base, California

On the west coast, the 30th Civil Engineer Group fulfilled missions associated with Vandenberg AFB space and ballistic missions. The location of Vandenberg AFB made possible launches into polar orbit while avoiding inhabited areas. Each launch was supported by 40 to 50 civil engineer personnel responsible for power production, equipment certification, EOD, fire suppression, and disaster preparedness. Each role performed by civil engineers was vital to a successful launch and critical in cases of disaster. In addition to launch support, civil engineers at Vandenberg AFB were responsible for maintaining the infrastructure required for the launch. Work included routine job assignments, as well as enhancements to the installation's military family housing.[430]

Teams began work on launch-specific power production as early as 10 hours before a launch. Five generator locations were typically readied as backup power supplies for each operation. HVAC personnel also were critical to each launch, ensuring the controlled environment for equipment and computers was properly maintained. Fire protection teams monitored each launch as well. They provided firefighting capabilities for small accidents and large-scale disasters, dispersing firefighting personnel throughout the air base during each launch. Disaster preparedness and EOD teams were on standby to provide assistance if a launch failed. Disaster preparedness teams were involved in every launch and fulfilled the duty of organizing a wing Disaster Control Group. EOD teams were utilized to dispose of broken or inadequate equipment and also to perform investigations to search for potentially dangerous items after a failed launch.[431]

Space and missile support programs offered civil engineers the opportunity to demonstrate their competence in advancing technologies. Their substantial contribution to the modernization and management of the Eastern Range facilities and their extensive involvement with space and ballistic launches at Vandenberg AFB allowed them to thrive in the growing environment of sophisticated space operations. These projects and responsibilities illustrated the skills and ingenuity that civil engineers contributed, making them vital participants in the entire Air Force space program.

B-2 Beddown at Whiteman AFB

The 1990s included several major weapon system beddown efforts, but none was more dramatic than the B-2 beddown at Whiteman AFB, Missouri. Originally a World War II training base, it became a B-47 bomber base in the 1950s and a Minuteman ICBM base in the 1950s and 60s. In 1987, Missouri Congressman Ike Skelton pushed for a new mission at the base and it was chosen to host the new B-2 bomber. Just as preparations were underway for a dual mission, the United States and the Soviet Union signed the Strategic Arms Reduction Treaty that meant the end of the base's missile mission. The base infrastructure was described as cold and industrial with aboveground steam lines everywhere. Base planners decided nearly every building would be demolished and replaced over a period of 10 years. This offered an opportunity for a comprehensive new look for the base. Beginning in 1988, the base's MILCON increased tenfold to more than $40 million for a decade. On the flightline, all but one hangar were torn down and replaced. Roads were straightened to create long thoroughfares and new landscaping developed. By 2003, about 99 percent of the facilities on base were new reflecting the $700 million spent on the base.[432]

Overseas Construction

The Air Force began a large construction program in Europe in response to the drawdown of forces and consolidation of bases. In USAFE, the drawdown of troops and base closures during the early 1990s reduced manpower and facilities from the level of the 1980s by approximately one-third. While some bases were closed, other bases expanded as activities were consolidated at fewer main bases. In Great Britain, the number of air bases was reduced from nine to two major operating bases. Relocation of units to RAF Mildenhall required $30 million in MILCON and Operations and Maintenance funds to be expended in an 18-month period. USAFE was able to complete the work through adopting design/construct contracts and working closely with local contractors.[433]

In 1988, the United States and Spain renewed their military agreement with the stipulation that U.S. forces at Torrejon AB, near Madrid, would vacate the installation by May 1992. As NATO still desired an Air Force presence in the Southern Region of Europe, debate ensued over where to construct an air base to accommodate the three squadrons of F-16s which comprised the 401st Tactical Fighter Wing (TFW).[434] Italy offered three possible sites for the construction of an air base: Lamezia, Oranova, and Crotone. All three sites were located in the southern region of Italy.[435] After surveys of each area were completed, Crotone was chosen as the location for the prospective rebasing of the 401st TFW. The preliminary plans for Crotone included "a runway, taxiways, aircraft parking facilities, and over 175 other facilities for operational, support, and community activities," as well as "housing, schools, a commissary and other facilities for approximately 10,000 personnel and dependents."[436] However, complications quickly arose concerning the construction of a new base. Time was a critical issue; the estimated completion date of Crotone AB was four to five years after the date when U.S. forces were required to leave Torrejon AB. The 401st TFW could either be disbanded or temporarily assigned to another base while Crotone was under construction. Congressional leaders vetoed the construction project in Crotone, Italy citing the decreasing military budget as just cause. Rep. Patricia Schroeder, head of the military construction panel of the House Armed Services Committee, noted, “When we’re closing 86 bases in the United States and building a new base in an area where the threat is severely lessened, people are asking, ‘What’s going on?’”[437] NATO willingly paid the majority of the construction cost out of its infrastructure budget, $887.1 million, and left 27.8 percent of the cost for the United States. However, the total cost of leaving Torrejon AB, relocating the units, and constructing housing added to the U.S. share for NATO infrastructure amounted to $468 million.[438] Congress canceled funding for the construction of Crotone AB in 1991.[439]

On May 4, 1992, the 401st TFW became the host wing at Aviano AB, replacing the 40th Wing. The move was meant to be temporary as discussions continued on constructing a new air base for the 401st TFW. Conflict in the Balkans in 1993 proved the necessity of keeping the 401st TFW at Aviano AB. In November of that year, a memorandum of understanding was signed between the United States and Italy for basing two squadrons at Aviano AB.[440] Once the permanent status of the 401st was confirmed, an evaluation of facilities revealed the need for expansion and renovation at Aviano AB. In January 1995, an Air Staff team led by Col. John Mogge visited the base and developed a planning document titled “Southern Stance.” Maj. Marvin Fisher, a member of the planning team, returned in June 1995 as the Base Civil Engineer and developed the Aviano 2000 plan which created a base redevelopment plan focused on creating eight functional centers on the installation. The base dated to the 1950s and was designed for a maximum population of 1,300; the addition of the 401st TFW doubled the population at Aviano. Col. Gary LaGassey, the program manager of Aviano 2000, quipped, “We shoe horned the unit into a base that couldn’t handle the move.”[441] A $535 million, 10-year construction project, Aviano 2000 was jointly funded by NATO and the U.S. Air Force, commenced in October 1995. NATO’s funding of base construction was unprecedented as the majority of the funding went towards military support and operations. In 1996, the Italian Air Force ceded an additional 219 acres (Zappala training area) to the 950-acre main base. The USAFE Civil Engineering office was the design and construction manager of Aviano 2000.[442]

Part of Aviano Air Base’s $540 million construction on the Aviano 2000 Program.

Aviano 2000 included 85 NATO-funded projects that covered the TFW and several upgrades and renovations for quality-of-life projects. The Air Force had 174 upgrade projects and the Italians had 12 NATO-funded projects. Major Fisher directed the development of a new base design guide that included designs featuring terra cotta roofs and paint schemes inspired by the local towns in northern Italy understanding the a key element of the base development was to ensure local political leaders would approve project designs. Local mayors that were part of the annual project approval process known as the Mixed Commission were concerned that future re-integration of the installation may be important to the local communities. Construction followed the Smooth Move Process in which every facility was to be completely furnished and ready for use within 30-60 days after the completion of construction.[443] Construction plans for Aviano AB included 530 housing units where previously all housing was off-base, new schools, hospital and several recreation facilities.[444] One of the goals was to ensure that housing was within 30 minutes of the air base.[445]

USAFE's infrastructure was in serious need of improvement by the 1990s. The command had a high number of temporary facilities, undersized facilities, old buildings (nearly half built before 1960), and 10,000 housing units with an average age of 42 years. Because of the uncertainty and downsizing in the basing throughout Europe, virtually no MILCON or military family housing investment funding flowed to USAFE in the mid-1990s. By 1997, Gen. Michael E. Ryan, USAFE Commander, and then-Col. L. Dean Fox, the USAFE Civil Engineer, developed a plan to "Fix USAFE." General Ryan made it a high priority to regain funding levels USAFE had experienced in the late 1980s. When additional funding became available, USAFE made improvements through MILCON, military family housing, and quality of life initiatives. O&M funding also lagged behind requirements and was only at preventive maintenance levels.[446]

Other major construction projects during the 1990s occurred at Ramstein AB, Germany. In 1994, the two fighter squadrons stationed at Ramstein AB were reassigned to Aviano AB, Italy. Ramstein AB was selected to receive the 37th Airlift Squadron, which was transferred from Rhein-Main AB. Services at Rhein-Main AB near Frankfurt airport were being reduced to half strength as part of the drawdown following the end of the Cold War. The Frankfurt Flughafen was to receive 326 acres of Rhein-Main AB and to contribute approximately $62 million in construction funds to support the transfer of the airlift mission to Ramstein AB.[447]

Major construction was required at Ramstein AB to accommodate the heavier aircraft to support the strategic airlift mission. The construction program included 14 phased projects in addition to NATO and the U.S. Air Force base-funded O&M projects. The primary projects involved reconfiguring the runway at Ramstein AB. Runway work including extending and hardening the runway overruns to support the larger aircraft, installation of drainage along the runway, reconstructing three taxiways, constructing a new parking ramp for eight C-130 aircraft, and upgrading an adjacent taxiway. Two maintenance hangars were upgraded and the squadron operations facility was renovated.[448]

The construction project at Ramstein AB was managed by Headquarters USAFE Civil Engineer Directorate and a partnership was formed between the German construction agent and the U.S. Air Force civil engineers to facilitate the design, contracting and construction processes. The 86th Civil Engineer Group was tasked with "coordinating base requirements during design, coordinating construction with ongoing airfield operations, and inspecting the construction."[449]

EDUCATION AND TRAINING

Education and training continued to be an area of emphasis for Air Force civil engineers through the 1990s. In particular, following Desert Shield/Desert Storm, training and education was tailored to satisfy the current needs of the civil engineer community, but also to address the projected requirements for the future. Training exercises and course curricula were assessed, modified, and refined to produce an engineering force capable of addressing any challenge.

Education

AFIT

The Air Force Institute of Technology (AFIT) continued the pursuit of educational excellence through the 1990s. The institute offered two primary avenues to a degree - through civilian institutions or through an AFIT resident program. The institute attempted to provide every opportunity for students to gain experience through a variety of courses within the School of Civil Engineering and Services. To accommodate students unable to schedule time away from their home stations, AFIT offered an On-Site Program. Rather than requiring students to travel to an AFIT facility, the program offered continuing education through mobile classes and tutorials. Coursework typically spanned two to five days. The program was convenient to students, but also saved money on transportation and per diem. It also alleviated the load for on-base personnel who otherwise would have to account for duties while participants traveled to an AFIT facility. Topics covered by the program included "Engineering Design and Programming, Engineering Management, MWRS (Morale, Welfare, Recreation, and Services) Management, Environmental Management, and Environmental Restoration Management."[450]

In 1993, to address the additional mission of MWR, the School of Civil Engineering and Services became the School of Civil Engineering, MWR and Services. The same year, a new $6 million, 54,000 square-foot building for the school was under construction at the AFIT campus, Wright-Patterson AFB, Ohio. The new building allowed the school to relocate from a facility constructed during World War II to a modern campus that featured computer labs, hands-on capabilities, and a larger, more efficient library system. The new facility featured 15 instruction rooms and an auditorium with a seating capacity

New Civil Engineering School, AFIT, at Wright-Patterson AFB, Ohio.

of 125. The construction was supervised by the U.S. Army Corps of Engineers. The modern schoolhouse addressed the ongoing needs of AFIT, providing students with a current facility and reflecting the growth of programs offered by the school. In addition, the building itself served as a learning tool. Glass panels allowed students to observe and study the building's mechanical systems, and electrical engineering students benefitted from the installation of a variety of electrical lighting arrangements to analyze. Also, rooftop walkways allowed students easy access to observe the building's roof systems as well as other construction aspects and building mechanics. Col. Steven Mugg, who served as Dean of the school during this time remarked that, "quality facilities promote quality education."[451]

The school continued to develop through the 1990s and modified coursework to address shortages in certain career paths. The institution also evolved to offer coursework and degrees proportionate in scope and intensity to its counterpart, the civilian school. In particular, the Engineering and Environmental Management program lengthened the duration of coursework during the 1990s to correspond to non-military educational facilities. The additional length of the program also offered the opportunity for instructors to increase the depth of study and allowed students to enhance their thesis work.[452]

During the 1990s, AFIT continued to address the education and training curriculum to prepare students adequately for their eventual roles within the Air Force. The school's major objective during this period was to prepare and graduate "mission ready" students by creating an "initial skills training" curriculum. The school intended to require students to complete initial skills training within their first six months of active duty. Officers enrolled in the school, completed seven weeks of instruction at the Civil Engineer and Services School and eight days of officer field education at the Silver Flag Exercise Site. Civilian students in roles comparable to officers, followed a similar curriculum but completed only the four weeks of instruction at the school. The course "Management 101, Introduction to the Base Civil Engineer Organization" was modified in 1995 to address the "mission ready" objective. The first half of the course presented students with a general perception of how civil engineer squadrons and flights were organized and what tasks were assigned to them. The second half of the course allowed students to apply themselves and consider their future goals; they were asked to divide into the following sessions: readiness, engineering, operations, environmental, or resources. Instructions offered in the second half of the course were tailored to provide in-depth information on these individual flights, including responsibilities, methods, terminology, and networking.[453]

The last portion of initial skills training was "ENG 485, Combat Engineering Course." This four-week course provided instruction in beddown operations, air base operability, and base recovery after attack. This was an important introduction to wartime operations for the new officers. Students also proposed strategies for beddown and airfield designs and were required to defend them to the faculty. The final component of the course took place at the Silver Flag Exercise Site, at Tyndall AFB, Florida, where students participated in officer field education. The field school covered heavy equipment, assets, services, fire and air base operability, and command and control. According to Maj. John A. Arin, who served as head of the Department of Engineering Management at the school, "leadership and familiarization with wartime assets and responsibilities underlie the theme of officer field education—creating civil engineer warriors!"[454]

At the conclusion of initial skills training, students were granted a CE career field badge. What they experienced through training and education during those eight weeks only gave them a glimpse of a day in the life of a civil engineer. A range of information was integrated into initial skills training. It provided a necessary background for students to understand their future roles as Air Force leaders.[455]

While modifying coursework to prepare officers as leaders, AFIT personnel also adjusted the graduate program to adapt to new programs. In 1991, the Graduate Engineering Management program was renamed Graduate Engineering and Environmental Management (GEEM). As a result of the emphasis on environmental, doctoral degrees in the field tremendously increased. A move toward environmental work being done by civilians or contractors during the mid-1990s resulted in a slight decline in environmental graduate degrees pursued through GEEM, leaving the program unbalanced.

As a result, civil engineer leaders began a more in-depth look at graduate instruction during the mid-1990s.[456]

Beginning in summer 1995, the GEEM program was expanded from 15 months to 18 months. This change was made to accommodate additional courses needed to address career requirements noted in the field. The expanded period of coursework also allowed students to focus more time on research. The majority of students enrolled in GEEM classes had acquired undergraduate degrees centered on technical material. GEEM was viewed as an extension of undergraduate study that allowed students to gain skills in management and eventually obtain leadership roles. Curriculum for the GEEM program was reviewed annually by the Program Review Committee (PRC). The PRC included representatives from each major command, AFCESA, AFCEE, and civil engineer Technical Training Schools. This review allowed the program to be specifically tailored toward producing vital personnel for the field of civil engineering.[457]

In 1995, the Graduate Education Subcommittee (GES) was created to concentrate on and to stabilize the curriculum offered by GEEM. In addition to the PRC, the GES assessed GEEM curriculum to ensure that the entire program was directly linked to the needs of the civil engineer community. GES included six personnel representing the civil engineer career field, an operating base civil engineer, as well as instructors and advisors from AFIT. During its first review in 1995, GES identified three concerns with the GEEM program: the program needed to reflect better the priority of preparing officers for a career field; the program lacked an adequate tracking device for students enrolling and graduating necessary to support the needs of the civil engineer career fields; and, the current curriculum needed a clearer focus.[458]

A three-step program was developed to address the issues. The first step identified civil engineer responsibilities within the career fields. Step two assessed the role of education in improving an officer's career. The third step combined the results of steps one and two to determine the appropriate curriculum for the graduate program. This process ensured a level of education higher than that gained through continued education programs or professional military education programs. The GEEM program integrated management and technical training to produce a graduate with the capability to pursue and excel at leadership roles.[459]

The GES assessment and the resulting three-step program to address identified issues changed the GEEM curriculum. These changes took effect in 1996. The restructured program included "11 core courses, plus one selective course; four courses forming a specialty sequence; three electives; and 12 hours of thesis research." Core courses included probability, statistics, engineering management principles, organizational management and behavior, operations management, quality control and management, decision analysis, environmental management and policy, environmental system engineering, economic analysis, and pollution prevention. Students chose two elective courses, either environmental risk analysis and operations research. These two selections allowed students to decide between an emphasis on engineering and an emphasis on environmental studies. The four courses that made up the "specialty sequence" permitted students to narrow their focus even more. The specialties for four of the sequences were, "environmental remediation, air resources management, engineering management, and environmental systems analysis and management." Upon completion, graduates received a Master of Science degree.[460]

Restructuring the GEEM program involved many people from across the Air Force. It was a time consuming, but necessary, task. The new curriculum prepared Air Force personnel from the bottom up, taking undergraduate students and turning them into leaders. The students entered the program with tools developed from various educational backgrounds and experiences; they left with a cache of wisdom and management skills. Along the way they gained advanced knowledge as well as confidence. Capt. Karla K. Mika, who completed her Master of Science degree through the GEEM program in 1996, remarked, "now, as [my class] scatters to Air Force bases (and one Marine station) around the world, committed to putting its education to use, the challenges of the degree begin to pale in comparison to the environmental, technical and leadership challenges that lie ahead. Armed with the knowledge we gained and the friendships and connections we made, each of us is better prepared to face those challenges." Less than a year after graduation Captain Mika became the Deputy Environmental Flight Chief for the 49th Civil Engineer Squadron at Holloman AFB in New Mexico.[461]

Graduate Educational Opportunities

Graduate degrees specific to the fields of civil engineering and services allowed civil engineer professionals to excel within a specific career field. They broadened the knowledge of potential Air Force leaders and exposed them to the larger realm of life as an Air Force civil engineer. Graduate degrees also increased opportunities for promotion. Potential students chose either an Air Force funded graduate program or an individual program offered through a civilian institution. There were advantages and disadvantages to both options.

The GEEM program at AFIT was the principal graduate school opportunity for civil engineers. The program was tailored to provide specialized core curriculum chosen by students from an established selection of courses. As graduates, these students would fulfill the requirements designated within a particular career path. Air Force funded graduate programs allowed students to gain their degree while remaining on active duty, permitting the student to be a full-time pupil focusing on their coursework. Being a full-time scholar on campus provided students the opportunity to immerse themselves in an atmosphere of peers. At AFIT, students worked alongside civil engineer officers and studied under faculty members with a wealth of knowledge in the civil engineer field; this was beneficial from every aspect.[462]

Students who chose to pursue advanced degrees through other institutions could complete their studies on their own time. Night school or other scheduling methods allowed students to coordinate their full-time on-duty work with their educational pursuits. The Air Force offered an education assistance program to help off-set the cost of tuition. Students who planned their own advanced education through other institutions had the benefit of remaining near their home station. This avoided relocation and a request for a permanent change of station required by programs such as GEEM.[463]

Officers could also gain graduate educations through the full-time Air Force sponsored Civilian Institutions program. This program was managed by AFIT and was mainly used for technical degrees to equip officers with the knowledge necessary for certain aspects of their U.S. Air Force career. Structural engineering, power systems, and soils were some of the technical subjects offered through the 15-to-18 month degrees. Degrees were also available in construction management and engineer management. Enrollment slots and the selection of degrees offered by the Civilian Institutions program were determined by the Air Force and fluctuated based on anticipated needs. [464]

U.S. Air Force Academy Civil Engineer Program

The U.S. Air Force Academy (USAFA) in Colorado Springs, Colorado, offered undergraduate coursework specific to the civil engineer career field. In 1995, the USAFA offered a new course in base-level civil engineering, Civil Engineering 351: Construction Practices, Field Engineering. Three bases in Florida accommodated training for the course, Hurlburt Field, Eglin, and Tyndall. Instruction ranged from construction and maintenance to fire protection and aircraft arresting methods. At Silver Flag, cadets participated in a two-week training course and were exposed to combat engineering procedures. After their field training, cadets completed additional weeks of work at the USAFA's Field Engineering and Readiness Laboratory (FERL). At FERL, they completed large projects and utilized heavy equipment. The course was provided to cadets prior to their design curriculum. This method of "construct first, design later" was intended to reinforce the knowledge and understanding that would be gained during later and more sophisticated design lessons.[465]

Projects at FERL were created by USAFA's Department of Civil Engineering; instruction was provided by ACC, AMC, ANG, and AFRES personnel. One cadet remarked, "I was surprised to learn that NCOs, Airmen and civilians supervise scheduling and complete all of the work on the construction sites…this course taught me that, as an officer who designs and manages civil engineering projects, I'll need to rely on their skills and experience to get the job done." The course allowed students to learn many new skills and also illustrated the challenges faced by civil engineers to prepare themselves and maintain readiness. It also demonstrated the procedures followed for an operation, including organization and management.[466]

The creation of the course was significant, because its purpose was to address deficiencies recognized by accreditation reviews. Organizing the curriculum was merely one step toward increasing student proficiency. The USAFA had to measure the success of the "construct first, design later" program through years of assessment. Scientists with the Armstrong Laboratory at Brooks AFB in Texas joined the Department of Civil Engineering to pinpoint the objectives of the course during the early planning stages. Once the curriculum was implemented, Armstrong Laboratory partnered with the Department again to determine if the objectives were appropriately achieved. Cadets, as well as their mentors, maintained notes on experiences encountered through CE 351. These were analyzed to create a tracking record of students.[467]

The performance of each cadet that participated in the course was traced through the first year of active duty. Supervisors were interviewed to assess accomplishments and to compare the performances of officers who participated in the course to those who did not. Lt. Col. Randall Brown, an assistant professor with the USAFA who oversaw implementation of the curriculum, remarked, "by combining feedback from the course participants and their bosses, we will continue to tailor and improve the program in an attempt to meet *all* our customer's expectations and requirements."[468] The implementation of this meticulous evaluation illustrated the investment involved with training and education. Coursework was not merely a task; it was a vital pursuit to prepare future Air Force civil engineers for domestic and international duties.

Technical Training

During fall 1992, Congress ordered Military Service Chiefs to oversee a review of military technical and operation training. The review was assigned to the Inter-Service Training Review Organization (ITRO) committee, which comprised representatives from each military service. The ultimate goal of the review was to assess avenues to reduce duplicated training and to cut costs. Detailed Analysis Groups began assessing civil engineer technical training throughout the military services. The Air Force analysis was led by Lt. Col. Scott L. Smith, who was the commander of the 366th Training Squadron at Sheppard AFB, Texas. The analysis of training resulted in a plan to merge "fire protection; heating, ventilating, air conditioning and refrigeration; electrical; utilities; structures; pavement and equipment operations; engineering; and, construction equipment mechanics." Training in these areas would be held at seven installations already equipped with training elements. Beginning in the fall of 1995, engineering assistants and equipment operators were trained at Fort Leonard Wood, Missouri. Plumbers were trained at Sheppard AFB, Texas. Electricians were trained at Sheppard AFB; Camp LeJuene, North Carolina; and Fort Leonard Wood. Structures (carpenters) were trained at Gulfport, Mississippi. Construction mechanics were trained at Port Hueneme, California, and Fort Leonard Wood. Technical training for HVAC/refrigeration was held at Sheppard AFB and Aberdeen Proving Ground, Maryland.[469]

Another modification to training was made by Gen. Merrill A. McPeak who designated 1992 as the "Year of Training." His goal was to ensure that enlisted personnel were "mission ready" when they reached their first assignment. General McCarthy met with General McPeak during the objective civil engineer squadron development to discuss enhanced training for a smaller work force. General

McCarthy said that it was imperative that the Air Force use some of the manpower savings to fund entry-level training for every Airman. He used the example that a new Airman in the air conditioning specialty was only qualified to push the on/off button when responding to a service call. General McPeak approved the request and subsequently expanded the initiative to all Airman specialties. As a result, all enlisted personnel were required to take technical training. Career Field Education and Training Plans (CFETPs) were established to lay out the necessary path for enlisted personnel, including required training as well as training projected to be beneficial in the future. In 1994, Headquarters AFCESA gathered subject matter experts to assess the CFETPs through workshops. The workshops addressed the Specialty Training Standards necessary for personnel to complete peacetime tasks as well as wartime/contingency tasks. Specific "core tasks" were identified to address the necessary training to adequately fulfill the duties of a particular specialty. In 1995, the CFETPs were released, establishing a career path for each individual civil engineer specialty. The plans directed personnel to the training requirements for each specialty, but also addressed the amount of time and effort required to get to a specific level within each career. The ultimate goal of implementing the CFETPs was to create a workforce trained to the maximum level of readiness.[470]

Personnel could not continue to a higher level of skill until they had completed each of their assigned core tasks, which encouraged supervisors to support training. The initial release of CFETPs was criticized by supervisors and commanders who pointed out that some of the identified core tasks were not necessary. Adjustments were made through workshops; eventually, the core tasks were decreased, creating a more feasible list of requirements. Workshop participants agreed that an annual review of CFETPs was necessary to guarantee that the plans worked efficiently and were kept current. By 1997, CFETPs were in place for civil engineer officers, civilians, and enlisted personnel.[471]

Technical schools allowed more specific instruction providing an opportunity for personnel to refine the skills necessary to fulfill their responsibilities. Technical training schools combined computer-based instruction with field training to create an integrated curriculum.

363d Technical Training Squadron

Civil Engineering training at Sheppard AFB, Texas, was provided by the 363d Technical Training Squadron until 1994 when the 366th Training Squadron, also at Sheppard, picked up the responsibility. Curriculum included four flights: Construction, Electrical, Fuels, and Mechanical. Air National Guard, Air Force Reserve and personnel from the active Air Force participated in training offered by the squadron. The 363d had a permanent staff of 450 instructors; more than 85 percent of them held associate degrees, and some possessed bachelor or masters degrees. Curriculum included in-classroom instruction as well as field training. Courses taught by the squadron were determined by assessing jobs completed in the field, addressing the needs of real world projects. Personnel from the major commands participated in workshops with the 363d to evaluate what courses were needed and what level of expertise was required.[472]

The 363d Technical Training Squadron offered 11 "AFSC-awarding" modules, including: Force Management; Pest Management; Management Specialist; Engineering Assistant; Heating, Ventilating, Air Conditioning & Refrigeration; Utilities System Specialist; Electrical System Specialist; Electrical Power Production; Structural Specialist; Fuels Specialist; Liquid Fuels Systems Maintenance; and, Pavement Maintenance & Construction Equipment. The range of courses illustrates the vast amount of possible specialties and skills a civil engineer could acquire. In addition, the 363d offered curriculum that could be taught at individual bases; this was provided by 12 traveling teams.[473]

Fire School

Fire protection personnel faced several training changes during the 1990s. The first major change occurred in February 1993 when DoD implemented the DoD Fire Fighter Certification System, which was an accredited program by the International Fire Service Accreditation Congress. Due to the U.S. Air Force's exemplary training program in firefighting, it became the executive agent for the certification program. Chanute AFB was closed by BRAC on September 1, 1993. The fire school moved to Goodfellow AFB, Texas, earlier that same year and classes resumed on August 16, 1993. The first classes immediately offered at Goodfellow included: 37-Day Apprentice Firefighter, Rescue Technician, Hazardous Materials Technician, Fire Inspector/Investigator, Firefighter Supervisor. The fire school at Goodfellow AFB became the DoD Fire Academy as other services joined the school and was renamed the Louis F. Garland Fire Academy in honor of Chief Warrant Officer Garland in 1995.[474]

EOD Training

In 1999, a new EOD training complex was completed at Eglin AFB, Florida. The Navy EOD School at Naval Surface Warfare Center, Indian Head, Maryland, was relocated to Eglin AFB and a ribbon cutting ceremony was held on January 1999. The $16.2 million project greatly enlarged the facility, as well as merged all EOD training into one location. The complex was named in honor of the late Rear Admiral Draper L. Kauffman. Admiral Kauffman was responsible for creating the first bomb disposal schools for the U.S. Navy and U.S. Army.[475]

Readiness Training

While numerous opportunities existed for academic advancement, various programs provided hands-on training through field exercises and readiness competitions open to the entire civil engineer community. In addition, humanitarian efforts allowed civil engineer forces to apply the skills acquired through education and training.

Silver Flag and Move to Tyndall AFB

Construction of the new training area at Tyndall AFB, Florida, was still underway during the early 1990s. The new 1,000-acre Silver Flag training site officially opened at Tyndall AFB on August 3, 1993. In addition to the move, the training functions were reorganized under Air Combat Command (ACC). This was part of General McPeak's restructuring; he wanted training to be the responsibility of major commands rather than under the field operating agency. As a result, Detachment 2, AFESC, which had been responsible for the site at Eglin AFB, was reassigned as Detachment 1, 823d RED HORSE Squadron. Detachment 1 was created to administer Silver Flag training with a stipulation; if the United States went to war, the detachment would resume its wartime posture. The Silver Flag site served many functions in addition to hosting Readiness Challenges. The officer field education program was moved from Eglin AFB to Silver Flag. This program also trained students in MWR and Services. Training was also given for beddown and general troop support, including food service and mortuary operations.[476]

In 1992, a Readiness Training Review of Air Force civil engineers revealed the need for enhanced training. The new program developed for Silver Flag focused on contingency exercises that coupled computer instruction with field training. In addition, the program instituted task certifications. These certifications were specifically for Prime BEEF team members that held unique UTC positions. The certification process was one example of applying the lessons learned from DESERT SHIELD/DESERT STORM.[477]

Brig. Gen. Michael A. "Mick" McAuliffe officialy opens the new Silver Flag Exercise Site at Tyndall AFB, Florida, while Brig. Gen. Clinton V. Horn, 325th Fighter Wing commander (left) and Col. John Fraser, 823d RED HORSE Squadron commander hold the ribbon.

The lessons learned gathered from DESERT SHIELD/DESERT STORM were an asset to addressing future training needs. One significant lesson applied to the lack of bare base asset training. Even though civil engineer teams proved their flexibility and determination by successfully providing beddown operations during DESERT SHIELD/DESERT STORM, it was clear that additional training on bare base assets would be indisputably beneficial. The new Silver Flag program curriculum assured major commands that training would address this need.[478]

From August 16 to December 17, 1993, the Silver Flag Exercise Site held courses to assess new curriculum. The 823d RED HORSE Civil Engineer Squadron, troops from USAFE and PACAF, and readiness personnel from Headquarters AFCESA were involved in field exercises, classroom training, equipment assessments, and a variety of courses as part of the evaluation. As a result of the assessment, modifications were made to the program's curriculum. Some courses and exercises were suggested, and others were adjusted for topic or time allotment. Additional Global Positioning System (GPS) courses were added to the curriculum to train troops to use the devices for airfield damage assessments and beddown operations. GPS was a revolutionary tool during this time; it was a resource that allowed the civil engineer community to further advance within aerospace technology. GPS devices were also used as part of a covert training exercise that combined overland transportation, mapping, and night vision. The exercise was planned to simulate activities during DESERT STORM. The evaluation of the new curriculum at the Silver Flag Exercise Site concluded in December. In closing, Col. Daniel J. Barker, who served as director of readiness for Headquarters AFCESA, stated "we extend our congratulations to everyone for their contributions to this effort…continued support is required to ensure our Prime BEEF personnel are ready to fulfill engineer contingency requirements in support of the AF mission."[479]

The timing of the establishment of the new Silver Flag site was fortuitous. The facility was capable of accommodating many requirements necessary to equip troops properly with the expertise to face a variety of scenarios. This was especially valuable to address the lessons learned during DESERT SHIELD/

Desert Storm. The Silver Flag facility offered a new and improved foundation necessary to build an enhanced force that faced new challenges and additional advanced technologies.

Another lesson learned from Desert Shield/Desert Storm was the need for increased Home Station Training. It was considered the first phase of readiness training; training specific to a particular task or piece of equipment was phase two. This type of training was available at the Silver Flag training site or other Team Training Sites. Opportunities to access equipment that was not always available at their home stations allowed engineers to become experienced on machines that they would otherwise only encounter during wartime.[480]

During the mid-1980s, Regional Equipment Operator Training Sites (REOTS) were created to address the "high-demand/low density" situation of the Air Force Reserve units and the Air National Guard Readiness Center. With Reserve and ANG Prime BEEF and RED HORSE teams dispersed across the country, regional sites for contingency training became necessary. It was not feasible for every ANG facility to acquire the equipment necessary for training. As a result, the regional training site concept was developed. The REOTS program centered on four pieces of equipment essential to RRR: the bulldozer, the grader, the excavator, and the front-end loader. The initial goal for the program was to "provide expanded proficiency training to the Active force, while the ARF [Air Reserve Forces] will use the sites for both introductory and proficiency training."[481]

Three training sites were projected as the necessary number to handle needs. Dobbins AFB, Georgia; Nellis AFB, Nevada; and, Fort Indiantown Gap, Pennsylvania, were chosen. It was estimated that 1,900 students would attend the training annually: 600 active duty and ARF students on a three-year rotation, with 1,300 per year. The instruction was considered wartime training, but also enhanced peacetime support. The REOTS schools at Nellis AFB and Dobbins AFB held their first class on June 13, 1988; the facility at Fort Indiantown Gap became operational in October 1989. Each site was periodically reviewed for curriculum and operation. Over the next decade, the REOTS program was expanded to include additional facilities.[482]

Foal Eagle Exercises

Foal Eagle exercises were beneficial to civil engineers. Not only did they learn specific skills that could be applied in other scenarios, but they also enhanced their deployment capabilities. These exercises were an effort to maintain and enhance relationships with the Republic of Korea (ROK).

During Exercise Foal Eagle 91 in Korea, civil engineers from Osan AFB practiced using berming and sprayed concrete, known as shotcrete. Work included repairing failing walls and columns. Training was completed to improve the skills necessary for rapidly repairing damaged resources. Foal Eagle 93 was a joint exercise in Korea involving U.S. and ROK military personnel. Approximately 35,000 troops from the CONUS partook in the exercise. Air Force civil engineers included 28 personnel from the 15th CES that deployed in October for 35 days. They trained at Taegu Air Base and maintained the base and an airfield. Their primary tasks included addressing urgent issues with plumbing and electrical systems and undertaking structural repairs. They also installed AM-2 matting to support an alternative entry for the airfield. When the exercise concluded in December, 292 work orders had been completed. With the exception of nine work orders, all were completed within a 24-hour timeframe. The 15th CES concluded the exercise with enhanced knowledge and confidence.[483]

In 1997, Foal Eagle exercises returned to Osan AFB. The 54th CES participated, bringing 28 personnel from Eielson AFB in Alaska. The primary mission of the CES was to support the tent city housing military personnel. They maintained 110 tents, provided utility support and repaired resources as needed. Foal Eagle 97 allowed the civil engineers to strengthen their beddown capabilities.[484]

Each Foal Eagle exercise revealed strengths and weaknesses, providing many lessons learned. During Foal Eagle 93, for example, one of the primary lessons learned was related to manpower. Prior to deployment of the entire team, three people from the 15th CES traveled to Taegu and assessed the location along with the specific requirements for the exercise. They determined that their original plan to deploy 43 civil engineer personnel was excessive. This allowed them to narrow the team and choose personnel based on specific capabilities. As a result, they avoided surplus personnel and also saved money. They took advantage of the opportunity to plan ahead and reaped the benefits.[485]

Exercise Green Flag 95

Exercise Green Flag 95 was a 6-week exercise staged at Nellis Range in Nevada. The objective was to perform flying missions within an electronic warfare setting. For the first time, Air Force civil engineers were requested to illustrate their competency in supporting camouflage, concealment, and deception (CCD) operations. The civil engineers arrived with devices such as camouflage netting, smoke generators, and inflatable aircraft and vehicle decoys used to simulate scenarios. Once in place, CCD resources were targeted by Air Force aircraft using sensors and human observation. At the conclusion of Exercise Green Flag 95, Lt. Col. "Bear" Bradshaw, who managed the exercise, stated the "CCD effectively defeated *every* threat sensor we used during the exercise…therefore *every* aircrew should be required to fly against CCD in both practice and training." This was a significant recognition for the civil engineer community, especially considering that the need for enhanced CCD capabilities was highlighted during the Gulf War. By gaining rave reviews from their performances at Nellis Range, the civil engineers proved their ability to employ advanced technologies and displayed their desire to enhance future warfare capabilities.[486]

Engineer Capstone Exercise 96

In July 1996, the largest deployment of U.S. troops to Cambodia since the Vietnam War occurred as part of Engineer Capstone Exercise 96. This joint and combined exercise had the dual role of providing humanitarian assistance through the enhancement of medical facilities within the isolated regions of the Kingdom of Cambodia. Troops reached the country during the peak of monsoon season. Eight Air Force civil engineers participated in the exercise, which included Army Special Forces, Navy Seabees, Army Engineers, Army Civil Affairs Personnel, and the Royal Cambodian Air Force. The civil engineers constructed support buildings, set up generators, ran electrical lines, and installed lighting. Larger projects included digging 320 post holes by hand and building 24-foot long 400-pound wood trusses. The civil engineer team was in Cambodia through August.[487]

They completed their tasks in a timely fashion and, before departing, instructed Royal Cambodian Air Force troops how to care for, run, and test generators. The Army Master Sergeant who served as deployment senior NCO during the exercise remarked, "it was a real pleasure having the Air Force engineers here. There was no messing around. These guys came to work and they did a great job, not just at the hospital but in always lending a hand around camp. They made a difference." Engineer Capstone Exercise 96 tested civil engineer ingenuity by placing them in remote areas with unpredictable weather. Civil engineers persevered and followed through with their tasks, learned new methods, enhanced their knowledge, and also helped the citizens of the Kingdom of Cambodia. In addition, the civil engineers strengthened their deployment capabilities and gained more experience working in a joint environment.[488]

A variety of educational and training options provided civil engineers the opportunity to build knowledge and confidence. In addition, these opportunities allowed personnel to experience realistic scenarios to prepare them for wartime contingencies. Through educational programs and specific training events, personnel gained experience in technical expertise, team building, and practical applications. These lessons provided personnel with a broader range of experience within the civil engineer community, but also afforded the opportunity to gain a worldwide perspective of the Air Force.

Readiness Challenges

Readiness Challenges offered participants opportunities to demonstrate their strengths independently and within a team during wartime scenarios and individual timed events. These biennial challenges were showcases of technical skills and time management. Although the challenges were competitive, they also reinforced an overall team mentality. Readiness Challenges combined engineering and services teams within the Air Force, but also eventually included participants and observers from allied nations. This encouraged participants to share knowledge while also allowing the Air Force to display their capabilities to a wider audience.

Readiness Challenge IV in 1993 was the last Readiness Challenge held at Eglin AFB. Nearly four years had passed since the last challenge due to rescheduling necessitated by Desert Shield/Desert Storm, Hurricane Andrew, and Typhoon Omar. There were many "firsts" with Readiness Challenge IV. Air Force DP and EOD personnel as well as allied forces were included for the first time. This was also the first challenge following Desert Shield/Desert Storm.[489]

Readiness Challenge IV included military personnel from eight major commands, Reserves, Air National Guard, and the USAFA. A team from the Canadian Air Force also participated. Inviting other countries to participate and/or observe was beneficial to all involved because it promoted teamwork in a combined atmosphere and also allowed techniques and information to be shared. Capt. Jean Morissette, a Canadian public affairs officer, remarked "this competition has a growing international appeal that exposes our people to new equipment, techniques and learning environments. It also allows for the development of friendships." One of the Canadian officers received the Maj. Gen. George E. Ellis Trophy for his "professionalism, leadership and teamwork." Readiness Challenge IV included crater repair, RRR, BRAAT, force beddown, moveable plane arresting procedures, runway lighting, and water purification. The challenge also included the use of Harvest Falcon kitchens and Harvest Bare kits. General McCarthy instituted the "Fog of War" event for RC IV because he believed that highly scripted and practiced events had led to a beauty contest mentality which did not represent a wartime scenario. General McCarthy and Colonel Wayne McDermott devised a close-hold event where teams were challenged with a surprise scenario, realism of special operational aircraft, and task saturation. This event tested teamwork and leadership under stress. During 1995's Readiness Challenge V, it was announced that the winner of the Readiness Challenge Fog of War event would be given the Maj. Gen. James E. McCarthy Readiness Trophy. Participants also learned new skills that diversified their capabilities in real-world situations.[490] The Air Force Materiel Command team took home the Meredith Trophy as the overall winner for RC IV.

Readiness Challenge V was held in April 1995; it was the first Readiness Challenge to take place at the new Silver Flag site at Tyndall AFB. It was a Total Force operation that included 12 teams representing each major command, the U.S. Air Force Academy, plus a team from the Canadian Air Force. Events included construction associated with beddown operations, the creation of mobile kitchens, and fire and rescue challenges. There were 21 total events; one in particular, the Fog of War, illustrated the realities of deployment. According to General Lupia, "the Fog of War gives the feel of a real-world experience that shows what a unit will need to accomplish once they get to a deployed location." For some participants, this was their first experience with such a scenario. Public Affairs personnel, who had provided media coverage for previous challenges, competed in the Fog of War for the first time during Readiness Challenge V. The event featured several situations, testing the logistical capabilities of teams within a set timeframe. Bare base assets were used to recreate an actual bed down of forces with a full complement of resources including electricity, food services, laundry, and billeting. The challenge also required the bare base operation to accommodate a landing helicopter. The Fog of War tested each team's abilities, while also illustrating the importance of working together.[491]

Some Prime RIBS teams provided services for the personnel of Readiness Challenge V; others, representing each major command, competed in challenges. SSgt. James Mitchell, who participated

The competitors charge off the starting line for the General Purpose Tent event at Readiness Challenge V, 1995.

in the challenge, remarked, "we came here together as a team. This wasn't about services or civil engineering…in this instance, the combined effort has made mission accomplishment an awesome experience. We don't worry about crossing some imaginary line. It's a team effort." Providing support services for the challenge allowed Prime RIBS teams to submerge themselves in the larger realm of a wartime scenario. This was particularly important for personnel who had trained for such an event, but had never actually experienced it. General Lupia remarked "this is an important event for the youngsters who need an understanding of the mission's mobility role." Readiness Challenge V, like its predecessors, presented an unparalleled opportunity for participants to take part in a large Total Force endeavor. It reinforced the importance of training, teamwork, and perseverance. Surprisingly, the U.S. Air Force Academy team was the overall winner for RC V. In previous years, the Academy team had been near the bottom of the pack.[492]

When planning began for Readiness Challenge VI, several nations were invited to participate or observe. Canada participated once again, along with a British Royal Engineer team. Observers from Germany, Japan, Italy, and Turkey also attended. Readiness Challenge VI was held in April and May 1997. It was the largest Readiness Challenge to-date, with 14 teams participating. Air Force Chaplain Services also took part in the challenge and were given the task of establishing a Chaplain Services Program. They were required to evaluate the religious requirements of the unit. This evaluation was then used to create and execute a program to address those requirements. Once again, Prime RIBS participated in the challenge.[493]

Some activities at Readiness Challenge VI were termed "superbowl events," with teams competing against each other simultaneously. These included the TEMPER (Tent Extendable Modular, Personnel) Tent with Heater; Hard-Back Tent Construction; Access and Recovery of Buried UXO; General Purpose Tent; and Camouflage, Concealment and Deception. The atmosphere of each challenge was tense, yet exciting. Team members cheered for their peers and the fast-paced environment was exhilarating. There were 25 events total, many of which illustrated the inventiveness that grew out of the accumulated experiences of previous Readiness Challenges.[494]

Similar to Readiness Challenge V, the Fog of War event during Readiness Challenge VI stole the show as the most impressive realistic scenario and the most mentally and physically challenging assignment. A fictitious air base, government name, and mission were designated. Teams were required to complete beddown operations in support of the mission; they also had to accommodate the landing of a C-130. Competitors were judged not only on time, but also on safety techniques and methods. In closing, General Lupia congratulated Team PACAF as the winner of Readiness Challenge VI. General Lupia clarified that with representatives from multiple nations, the "ultimate winner is the Free World… our world today demands countries work in cooperation. We must be prepared not only for combat in wartime but also for any number of military operations other than war. We will serve side-by-side and together we will triumph."[495]

Readiness Challenge VII was planned for April and May 1999. Twelve Air Force teams were slated to participate, along with representatives from Canada, the United Kingdom, Germany, Norway, and Japan. The challenge was postponed as a result of the crisis in Kosovo; however, the UK team chose to complete their trip to Florida. At Silver Flag they competed against each other, holding several events incorporating an "obstacle course, pallet build-up, ventilation and fire rescue, CCD, and TEMPER Tent construction." They viewed the experience as vital to their training objective.[496]

Readiness Challenges provided an abundance of skill-building and team-building experiences. The competitions also provided significant exposure for the combat support mission. The events were routinely observed by senior leaders, who were able to witness the accomplishments and dedication of civil engineers and services personnel. In a 1998 interview, Col. Frank J. Destadio, who served as the PACAF Civil Engineer, explained that Readiness Challenges grant "civil engineering individuals an opportunity to focus on their wartime skills and develop the techniques they need to accomplish wartime tasks. It also stimulates creativity." Participants gained proficiency, experienced new scenarios and tactics, and built confidence. They also garnered a strong appreciation for the importance of teamwork and team support. The challenges were physically and mentally demanding, providing a variety of realistic scenarios. They were a vital part of training within the engineering and services community; they also were crucial for maintaining relationships with allied forces. General Lupia summed up this importance following Readiness Challenge VI, "from this competition we all take home the knowledge that our forces and those of our allies have the organic capability to support the people, the weapons systems, the operations and the deployments that will keep our world and way of life safe."[497]

Perhaps the most noteworthy indication of the real value of Readiness Challenge occurred in 1990. In late July, Tactical Air Command was holding its internal competition at Hurlburt Field, Florida, to determine which base would represent the command in the overall Readiness Challenge competition. Brig. Gen. Michael A. "Mick" McAuliffe, the TAC director of Engineering and Services recounted what happened:

> We were down doing Readiness Challenge; we were preparing to find out which TAC team was going to go whip up on the rest of the Air Force at the Air Force Readiness Challenge when the bell rang. We literally sent people home from the TAC Readiness Challenge to suit up and go over there [for Desert Shield/Desert Storm]. They simply pulled off the line of the competition, went home, took their tool boxes, got on a C-141, and went to war. We simply did it.[498]

Engineering and Services personnel who were practicing their wartime skills for a competition soon had the opportunity to demonstrate them in a real-world environment.

DEPLOYMENTS

Introduction

During the 1990s, the United States participated in a variety of multilateral operations that involved joint actions among the U.S. Armed Forces and combined operations with forces from other nations. Presidents George H.W. Bush and William Clinton worked with other nations through the United Nations (UN) and NATO to build coalitions to support military actions. Air Force civil engineers served on joint task forces that involved all U.S. services in combat, humanitarian, and civic action deployments. In combat zones, Air Force civil engineers were likely to bed down joint service teams, as well as teams manned by Air Force personnel. In humanitarian deployments for training situations, Air Force civil engineers worked alongside members from other U.S. services to set up joint task forces and to execute missions. Greater numbers of deployments in both combat and humanitarian situations involved teams with active duty, Reserve, and ANG civil engineer personnel working side-by-side to accomplish the mission.

The 1990s began with U.S. Air Force participation in Desert Shield/Desert Storm, a war that required large-scale, combat operations. With the end of the Cold War, the dissolution of the U.S.S.R., and the freeing of Kuwait, most people expected a decline in military action for the rest of the decade. The term "peace dividend" was used to describe the expectation for a smaller, less active U.S. military. However, the decade of the 1990s was anything but quiet for Air Force civil engineers as they found themselves involved in several military operations in Bosnia, Somalia, and Kosovo, while continuing operations over northern and southern Iraq.

A new reality for Air Force civil engineers was an increasing number of deployments, or increased operations tempo. Between 1949 and 1989, seven peacekeeping operations were fielded by the UN. In 1994 alone, the number of deployments for U.S. troops rose to 17. These deployments included peacekeeping operations, humanitarian missions, drug enforcement efforts, and disaster relief.[499] Deployments surged during short-term combat situations, while peacekeeping operations often required long-term commitments that necessitated frequent rotations of military personnel. The increasing number and length of deployments put stress on deployed personnel and their families. Non-deployed military personnel and civilians also faced challenges in maintaining work flow at the home bases. By 1996, ACC reported that the number of deployed military civil engineers averaged 500-600 at any one time throughout the year. The ACC commander believed that extensive deployments overtaxed civil engineer personnel and established the goal that deployments for temporary duty assignments be limited to 120 days in a 12-month period. ACC Civil Engineer Brig. Gen. Earnest O. Robbins II was tasked to review civil engineer deployments to meet that goal and to ensure that work was spread evenly among all personnel in all wings and the two RED HORSE units within the command. Deployments longer than 120 days in 12 months impacted the deployed individual, his or her family, and the civilian colleagues left behind to cope with an extra work load on the home base.[500]

At the end of the decade, joint cooperation among the U.S. services was crucial to the performance of the military. Maj. Gen. Earnest O. Robbins II, who became The Air Force Civil Engineer in July 1999, praised the gains made in inter-service cooperation through consolidating training programs, standardizing equipment and operating techniques, and standardizing design and construction technical criteria.[501]

Operations Desert Shield/Desert Storm

On August 2, 1990, Iraqi armed forces under the command of Saddam Hussein swept into Kuwait and seized Kuwait City. Iraq's troops continued southward to position themselves on the Saudi Arabian border. Iraq announced the annexation of Kuwait on August 8, 1990. Fearing that Iraq had designs on the oil fields of Saudi Arabia, as well as those in Kuwait, U.S. President George H.W. Bush denounced the Iraqi attack as "naked aggression." On August 4, 1990, Gen. H. Norman Schwarzkopf, Jr., and Lt. Gen. Charles A. Horner, Commander, U.S. Air Forces Central Command (USCENTAF) briefed President Bush and his top advisors on a plan to send enough air power into Saudi Arabia to deter Saddam Hussein and to allow time for the U.S. Army to deploy 250,000 troops. The operation was named Desert Shield. On August 6, 1990, the king of Saudi Arabia met with senior U.S. officials and agreed to accept foreign military troops deployed to protect his country. U.S. Air Force aircraft began deploying to the region, including F-15s from Langley AFB, Virginia, and B-52s.[502]

Meanwhile President Bush sought to form an international coalition of nations to deal with the crisis to avoid the appearance of the United States acting unilaterally or a group of non-Arab countries fighting against a single Arab state. He worked with the UN to obtain Security Council resolutions that condemned Iraq's invasion of Kuwait and then imposed sanctions and embargoes against Iraq. President Bush was able to build an alliance against Iraq comprising 38 countries, including the U.S.S.R. and several Arab states. On November 29, 1990, the UN authorized "all means necessary" to restore international order if Iraqi forces did not leave Kuwait by January 15, 1991.[503] On January 12, 1991, the U.S. Congress voted by a slim margin to authorize the use of U.S. forces to drive Iraq out of Kuwait. While the political support was being marshaled, the physical build-up of forces continued. By January 15, the U.S. Air Force had 1,133 aircraft in place. The U.S. Navy and coalition forces contributed 1,481 aircraft to the effort. The Air Force military airlift had transported 500,000 personnel and over 3.7 million tons of dry cargo to the area.[504]

On January 17, 1991, Operation Desert Storm began when Special Operations helicopters, stealth fighters, and cruise missiles conducted airstrikes in Iraq. The initial assault tore a wide hole in the Iraqi air defenses, allowing a strike force of 650 coalition aircraft in to destroy selected targets. Air strikes continued throughout January 1991, lasting 41 days; the air-land-sea battle, lasting 100 hours, began in February. By February 28, 1991, the ground war was over.[505]

Although members of the USCENTAF staff deployed with the initial deployment to Saudi Arabia, Brig. Gen. Michael "Mick" McAuliffe recognized that they needed a colonel to head up the office and he immediately thought of Col. Karsten H. Rothenberg. He recalled,

> I knew that I needed a colonel in the game. I needed to have the raw power and I called Colonel Bob Courter, AFLC/DE, because Bob owns him [Colonel Rothenberg]. I said, "Bob, he's the guy for the job." We negotiated and I said, "I could send one of my guys. Wayne McDermott is certainly every bit as capable as a warrior. But Karsten has been over there many times and understands the culture. I think he would be the guy for the job." We agreed upon that and I remember talking to Maj. Gen. [Joseph A.] Ahearn and Brig. Gen. [James E.] McCarthy, telling them that Karsten was the guy for the job and that there was a consensus within the hierarchy of Engineering and Services. I went to the Battle Staff and talked to Maj. Gen. Mike Ryan, who was the USCENTAF/Rear Battle Staff director, and said, "I need to get a colonel in the game. I need to have you send a note over there to General Horner telling him that we want to send a colonel as DE." He did this via the telephone. He said, "You're cleared to do that."[506]

In this position, Colonel Rothenberg oversaw all the beddown operations that occurred in the area of responsibility (AOR). Colonel Rothenberg's 18-person staff was selected from the existing USCENTAF Engineering and Services Directorate (USCENTAF/DE) at Shaw AFB, South Carolina, and augmented by Airmen from several Air Force major commands. This group worked around the clock to "plan and coordinate the distribution, installation and maintenance of more than $400 million in bare base assets pre-positioned in the AOR; initiate $100 million in billeting, food services, and laundry contracts, and to provide beddown, food, laundry, and fire protection."[507]

USCENTAF/DE Forward was supported by USCENTAF/DE Rear, which was headed by Col. Wayne McDermott, and located at Headquarters TAC, Langley AFB, Virginia. The role of USCENTAF/DE Rear was to allocate Engineering and Services personnel to the AOR, to identify specific equipment needs and training requirements, and to coordinate specific assignments in the CONUS to support the war effort.[508] General McAuliffe tasked AFESC to support TAC and USCENTAF/DE Rear. AFESC was assigned resource management and integration functions.[509] AFESC worked closely with CENTAF and TAC at Langley AFB, and regularly attended meetings and briefings. AFESC also purchased computer equipment to link USCENTAF/DE Forward and Rear, Headquarters TAC, AFESC, and the Air Staff. This computer system provided instant access to information to monitor the status of beddown and air base construction at each forward location. Information collected through this system allowed AFESC personnel to respond to problems quickly and to anticipate future requirements.[510]

At Tyndall AFB, Florida, Lt. Col. John W. Mogge, Jr., Chief, Readiness Policy division, directed sixty AFESC personnel dedicated full time to Desert Shield/Desert Storm.[511] Colonel Nay also established a multi-functional division in the Readiness Directorate. The new division comprised seven teams that pulled support from other organizations, as needed. The Engineering and Services Center Readiness Center operated around the clock, seven days a week. Readiness Center staff was augmented with fire, pavement, services, CEMIRT, mortuary, and equipment specialists.[512] AFESC's main task was to integrate Prime BEEF, Prime RIBS, and RED HORSE operations, to help ensure that they were mobilized and dispatched, and that they were trained and ready.[513] Other assignments included:

- Dispatching Center personnel for temporary duty;
- Coordinating requirements for deploying Engineering and Services units;
- Reallocating both active and reserve forces to backfill critical jobs at air bases which have launched their forces for overseas;
- Designing and conducting special training classes for deploying teams at Det. 2, AFESC, Eglin AFB, Florida; and,
- Satisfying technical and logistical requirements being experienced in the theater.[514]

AFESC created an acquisition cell to identify off-the-shelf solutions for problems encountered at deployment locations. One problem solved by the acquisition cell was locating the appropriate tool to shape straight metal structural elements into arched supports to construct aircraft and equipment shelters, known as K-Span structures.[515] The cell also responded to a requirement for an early warning and alert system at Desert Shield sites. Within 35 days, the members designed, procured, tested, and delivered "Giant Voice" systems to bases in the AOR. Other equipment purchased for the war effort included an expedient airfield marking capability, self-help laundry systems, ice machines, and bench-style mixers.[516] In response to an urgent field request for improved kitchen equipment, the acquisition group identified the requirements, prepared a request for proposal, and procured a new mobile kitchen unit.[517] The Operations and Maintenance Directorate provided data regarding potable water, wastewater treatment, and airfield pavements and soils to support teams constructing and maintaining bases and airfields. The CEMIRT team provided logistical support, both in the field and CONUS, on electrical and air-conditioning system maintenance and the construction of power distribution systems. AFESC's traveling teams were available on an as-needed basis to provide field support.[518] One team deployed to Saudi Arabia with folded fiberglass mats and equipment to train airfield recovery teams on procedures for patching runway craters using the new materials. Fiberglass folded mats had just been accepted for operational use by TAC.[519]

Civil Engineers Deployed in the Gulf War

> In our peacetime roles, we are developers, operators, maintainers and firefighters, food providers, billeting specialists and innkeepers, family housing landlords, morticians, and protectors of the environment. Today, we are warriors.
>
> -Maj. Gen. Joseph A. Ahearn, September 1990[520]

The main mission of Air Force civil engineers sent overseas for the Gulf War was to bed down personnel and airplanes, and then operate and maintain those bases. They worked in diverse environments and supported projects that required a variety of skill levels. Duties ranged from general maintenance and management to heavy construction. Locations ran the gamut from established airfields with modern structures, to underdeveloped sites with limited resources. The Air Force established 19 bases during its initial set-up overseas: five in the United Arab Emirates (UAE), one in Egypt, one in Qatar, three in Oman, one in Bahrain, one in Diego Garcia, and seven in Saudi Arabia.[521] President Bush authorized supplementary troops in the Gulf during November 1990. As a result, civil engineers entered a period termed Phase II, which incorporated the continued build-up of sites. The Air Force also required two new sites in Saudi Arabia during this period, King Khalid Military City (KKMC) and Al Kharj.[522]

Prime BEEF teams generally deployed for the Gulf War in groups of 50 or 100. Firefighters typically deployed in teams of 12, 24, or 48. Prime RIBS personnel usually were sent in groups of 9, 18, or 25. (Other specialties such as Contracting and Finance specialists, deployed with Prime BEEF teams to assist with force beddown activities.)[523] ANG and Reserve personnel also were mobilized to support operations overseas. In addition, over 1,148 ANG, 867 Reserve, and 301 Individual Mobilization Augmentees (IMA) were mobilized to backfill deployed civil engineer positions.[524] General Lupia, then Deputy Chief of Staff for Engineering and Services at Headquarters AMC, stated that ANG and Reserve personnel formed an important and integral part of AMC's operations. Active duty civil engineers in AMC numbered 3,200 personnel, while ANG and Reserve civil engineer personnel numbered 7,500, forming 77 percent of a Total Force of 10,700 people. ANG and Reserve civil engineers served alongside active duty personnel on all missions.[525]

Ideally, teams were deployed to destinations along with their aircraft unit, but were adjusted for size depending on what type of support was needed; however, realistically, there were many unknowns. In many instances, host nations did not provide base mapping, making the coordination of troops, materials, and machinery particularly challenging.[526] RED HORSE units remained under the direct command of General Horner and USCENTAF/DE Forward assigned specific tasks as needed.

Another difficulty with deploying troops was the constantly evolving process of assessing the resources necessary to support a particular need and organizing those resources efficiently and effectively. In 1989, USCENTCOM began development of an Operations Plan (OPlan) that specifically addressed the potential for an Iraqi invasion of Kuwait. The resulting exercise, Internal Look 90, began in July less than a month prior to Iraq's actual invasion of Kuwait. It was a joint exercise that took place at Fort Bragg, North Carolina, and Hurlburt Field, Florida.[527] One necessity discussed as part of the OPlan and Internal Look 90 was the creation of a specific planning mechanism to allow the Air Force to precisely pinpoint the number of troops needed to support a particular site. Capt. Wayland H. Patterson, who served as Chief of the Exercise Branch for the USCENTAF Directorate of Engineering and Services, described the following ideal scenario: once a site was determined, "using the War Mobilization Plan, you look up so many of a certain type of aircraft and it tells you how many maintenance people, etc. that go with an aircraft package. So now you have a beginning site population." This formula for planning was ideal, but when Desert Shield/Desert Storm began, the mechanism was only a discussed concept. According to Captain Patterson, "there was no mix of aircraft, or where they needed to go, population or any of that stuff. It was only a theory. So it was a little rough going."[528] This does not mean that the Air Force and armed forces in general were not prepared.

Instruments were in place for organizing deployments, but the scope was astounding. The Gulf War necessitated the biggest deployment in United States history within a six-month period. Prime BEEF teams began arriving in theater on August 8 with the early teams going to Riyadh AB (from Langley and Offutt AFBs) and Dhahran AB (from Langley AFB), Saudi Arabia; Thumrait AB (from Seymour Johnson AFB), Oman; and Al Dhafra AB (from Shaw AFB), UAE. Lt. Col. David J. Ruschmann, who was involved with the early stages of Desert Shield from the TAC Readiness perspective, clarified what the media during Gulf War glossed over.[529]

> One overall perception that has been left by the media, and has even slipped through in printed interviews of some of our military personnel, is that support for Desert Shield was conducted as a no plan operation for deployment support. This is not true…the Air Force's SWA OPlan was a dynamic, updated plan, and had the basic requirements in sufficient detail, was well developed for pre-positioned assets, and considered the long resupply lines and lift shortages. It was a good starting baseline for execution planning.[530]

Colonel Ruschmann recognized the evolutionary nature of planning in an accelerated environment, stating that "there are lessons being learned that will affect not only the Air Force structure well beyond this decade, but also the overall structure of the armed forces."[531]

Even with plans in place, the U.S. military faced two major issues: the distance between CONUS and SWA necessitated heavy reliance on host nation support and the shortage of pre-positioned assets meant a heavy reliance on transportation and logistics. Internal Look 90 was clearly a beneficial and timely exercise. It illustrated the key and immediate needs required to face the impending war. One crucial realization was that, in order to gain a vital upfront lead, the U.S. military had to put forward a strong visible force. Although ideal deployments were phased to allow major preparations and beddown prior to the arrival of aircraft and their crews, the Air Force had no choice but to deploy fighter aircraft as quickly as possible. The initial hustle to deploy was understandably chaotic; decisions had to be made quickly and expectations often dominated judgment. Once airlifts began, engineers were frequently left behind to make room for other provisions. As Colonel Ruschmann observed, planes were frequently overloaded with equipment and supplies and therefore could not accommodate Engineering and Services personnel. This delay required deployed troops to fend for themselves for accommodations and sustainment or depend upon their host nation. U.S. Air Force Engineering and Services personnel often had no alternative but to arrive afterward and make up for lost time.[532]

Air Force civil engineers deployed to sites to perform beddown, often with few resources. During Desert Shield, Harvest Falcon kits were first used for contingency operations.[533] Harvest Falcon kits comprised one housekeeping set, one industrial operations set, and one initial flightline set to accommodate 1,100 personnel and one aircraft squadron. Ideally, during constructing of a bare base, the housekeeping set was the first component on the scene. Facilities for shelter, food, and hygiene were assembled using TEMPER tents. Utilities were connected as each facility was completed.[534] The next set to arrive at the bare base was the industrial operations set that contained additional TEMPER tents, hard wall shelters and expandable shelter containers. This phase of construction produced the structures to house civil engineer shops, vehicle maintenance, administration, and chaplain services. The next phase involved the construction of the initial flightline set. This set supplied structures to house maintenance, operational support, and utilities for one aircraft squadron.[535] As the bare base grew in size, additional sets were required to provide adequate support for personnel and equipment. Construction at a bare base was staged to support and launch aircraft within 72 hours after arrival at the site.[536]

Capt. Marvin N. Fisher was Chief of Operations for the 363d CES at Shaw AFB in South Carolina when Kuwait was invaded. As part of the 363d Tactical Fighter Wing assigned to SWA, Captain Fisher had no doubts that his troops soon would be deployed. Although initial communications indicated his troops were destined for Dhahran on the eastern coast of Saudi Arabia, the Prime BEEF team he led was sent to Al Dhafra AB, UAE.[537] His account of the initial beddown of troops overseas conveys the reality of military operations:

> This was the first time U.S. Air Force personnel had been in the UAE for any extended period…they were very possessive of what they were going to allow us to do and what we were allowed to use in the initial stages. They basically said, "Here's the caravan area and you can put your tents here." They didn't allow us to survey the land and pick the best site, like the book says you are supposed to do. They said, "Here is where you put your camp," end of discussion. Being an accommodating guest, we said, "Thank you," and proceeded to plan from there.[538]

Captain Fisher's Prime BEEF team was the largest single Prime BEEF team involved in the Gulf War, with 176 personnel. Its initial mission was to create a "city" to accommodate the 363d Tactical Fighter Wing. Captain Fisher explained the setup of Al Dhafra,

> Basically, we went out to see where the runways were and the direction of the prevailing winds. You want to put your showers and latrines and generators on the downwind side…I took out a piece of paper and mapped out the general layout [for the site developers].... We had used the wagon wheel method before and knew that we needed blocks of 200 x 100 feet for each billeting wheel, as we called them. They just basically went out and laid out the blocks. From there we put up tents and adjusted them as we went along. Once the equipment arrived, the first priorities included setting up tents and latrines for personnel. Each wagon wheel was set up with 12 tents to a wheel. A single 100 kW generator on one SDC [secondary distribution center] supported 12 tents with air conditioning. Additional wheels were added as a "building block system."[539]

Fortunately, the Shaw unit had been on two previous deployments into Oman and was familiar with the Harvest Falcon equipment and how to set up a base camp quickly. The wagon wheel design offered more camouflage for the base, as Captain Fisher explained, "until you are pretty much on top of it, you couldn't see it."[540]

Troops at Al Dhafra worked in shifts to speed construction and to avoid the severe heat. Transportation to and from the flightline where materials were delivered was limited. Supply delivery was further complicated by the fact that no engineers were available to assist on the shipping end. As a result, many items arrived out of sequence slowing down the construction process. The civil engineers also installed the air base infrastructure, including underground cables to accommodate the large generators and water lines to supply kitchens, restrooms, laundry facilities, and a hospital. In addition, the civil engineers were responsible for redirecting roads and supporting the maintenance of planes, including the construction of trim pads and barriers.[541] Engineers at Al Dhafra additionally fenced in the area and constructed a "moat" that encircled the entire camp.[542] Al Dhafra became the ammunition depot for most of the munitions in the UAE. Engineers built approximately 64 berms for ammunition storage.[543]

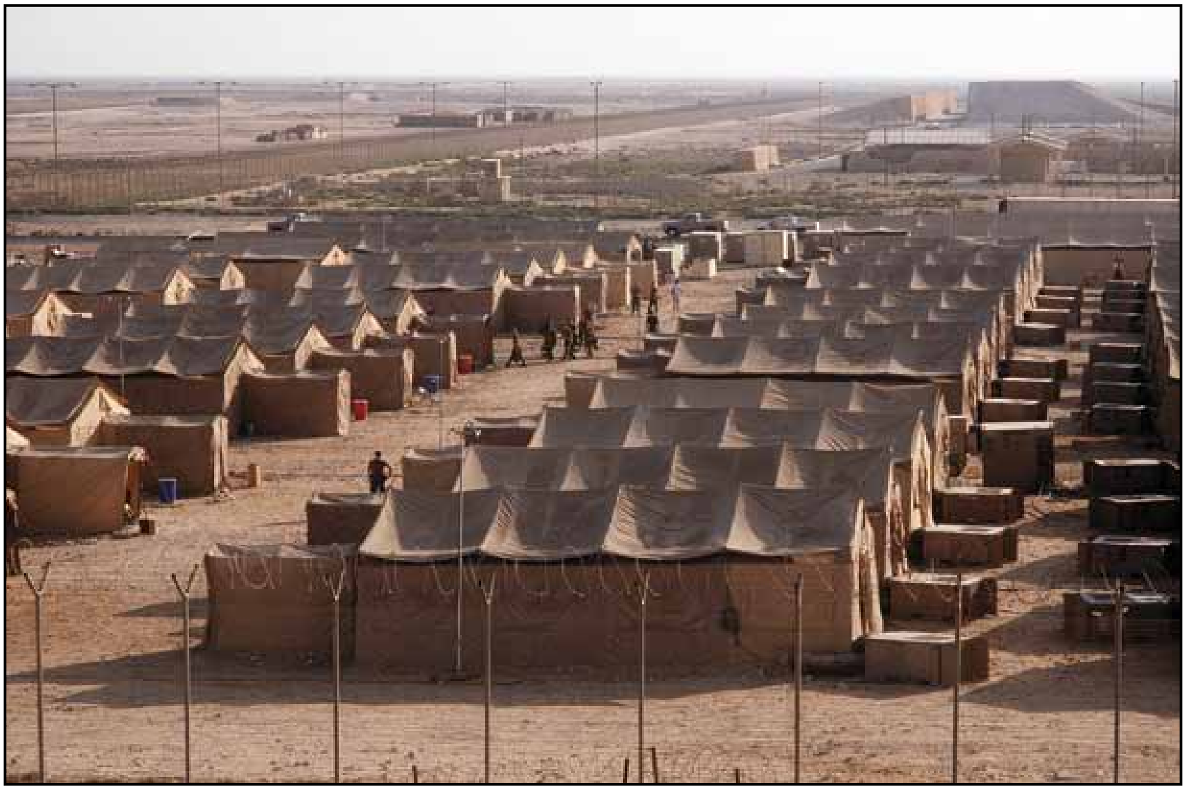
In addition to beddown restrictions put in place by host nations, other deviations from an ideal scenario included the separation of established teams and the last minute formation of new teams. When teams were created from varying groups, some leaders reacted differently than others. Some leaders viewed the separation of troops as damaging to the teamwork mentality, while others thought it was a good way to expand knowledge and encourage new camaraderie. Lt. Col. Rodney Hunt, who had just arrived at the 820th RED HORSE Squadron, was selected to lead the Prime BEEF team formed from the 99th CES at Nellis AFB because of his deployment experience. His team of personnel was

An aerial view of the Air Force compound at Al Dhafra AB, UAE. Note the "363 CES" near the bottom of the photo, telling everyone the civil engineers deployed from Shaw AFB, South Carolina, built the tent city.

initially deployed to Khamis Mushait Air Base, Saudi Arabia. Colonel Hunt immediately assessed the area and determined that his workforce was better utilized elsewhere. Within days, he relocated to Doha, Qatar, to assess the potential greater need for his team of engineers.[544] Two days after his arrival in Doha, Colonel Hunt was joined by a group of engineers from Spangdahlem AB, Germany. "Boom, they just showed up—a captain, a senior master sergeant, a couple of masters and 35 guys. I said, 'Well, why are they sending you? I've got 95 engineers sitting at Khamis.'" Eventually, Colonel Hunt combined portions of his Prime BEEF team with the engineers from Spangdahlem AB. Some commanders saw this as a potential threat to unit integrity, but the troops worked well together and eventually formed their own team. Last minute changes in location and assignments such as this one were common, especially during the early deployment period.[545]

In addition to inevitable changes and relocations, the troops were also dealing with relatively unknown bare base assets. Most civil engineers lacked the necessary training and were at a loss as how to construct and use the equipment. Recent pre-deployment training, especially in regards to bare base assets, proved to be an advantage to deployed Air Force civil engineers. Engineers from the 4449th MOBSS also were deployed to SWA to assist in setting up the kits, fixing equipment, and training other personnel on the Harvest Falcon kits.[546]

The RED HORSE ADVON (advance echelon) teams (RH-1) were particularly effective for initial assessments during the early deployment period. In August 1990, the 17-person ADVON team of the 823d RED HORSE Squadron deployed to Dhahran, Saudi Arabia. Arriving in September, the team assessed the area for an appropriate site for RED HORSE headquarters. The Saudi Arabian government suggested a beddown site, Eskan Village near Riyadh in central Saudi Arabia. The 7319th RED HORSE



A view of the Air Force tent city at Doha, Qatar.

Civil Engineering Flight stationed at Aviano Air Base in Italy provided assistance by transferring equipment to Saudi Arabia for use by RED HORSE. The 823d RH-2 team arrived in October and was soon followed by the 823d RH-3 team and the 820th RED HORSE RH-1 and RH-2 teams in November 1990.[547] The 820th RED HORSE Squadron deployed 109 personnel to Saudi Arabia in November.[548]

RED HORSE Echelons

RED HORSE squadrons were created following a manpower requirement of 400 personnel per squadron. Each squadron contained three echelons, RH-1, RH-2, and RH-3. The three designations carried different UTCs and corresponding missions established by Headquarters AFESC through the major commands.[549]

RH-1 was an advanced echelon (ADVON) with 16 personnel. Their primary missions included advanced airfield analysis, bed down, and collection of data necessary to predict and support future echelons. RH-1 echelons were capable of deploying from the CONUS within 16 hours' notice and could remain self-sufficient for five days. They required 4 vehicles and 12 short tons of equipment. Personnel and equipment could be transported within one C-141 or two C-130s.[550]

RH-2 was a light construction echelon with 94 personnel. Principal missions included site preparations and improvements necessary for beddown, construction of temporary facilities, RRR, renovation or demolition of resources, installation of aircraft arresting barriers, and establishment of water wells. They also supplied preliminary civil engineering support to other deployed troops, with the exception of firefighter operations. RH-2 echelons deployed within 48 hours of notification and required 58 vehicles and 455 short tons of equipment. They were transported by a C-141 or a C-130; when necessary, additional equipment was transported by a C-5. RH-2 echelons could remain self-sufficient for 60 days if they had access to necessary replenishments.[551]

continued

RED HORSE Echelons *continued*

RH-3 was a heavy construction echelon with 294 personnel. Their missions included heavy repair of buildings and infrastructure, construction of temporary facilities, demolition, RRR, and operation of plants. Personnel and equipment for the echelon could be transported within six days of notification. They carried 99 vehicles and 994 short tons of equipment. Transportation for RH-3 required C-5 aircraft; some equipment for the echelon was pre-positioned and transferred to their location by ground. Similar to RH-2 echelons, RH-3 could remain self-sufficient for 60 days if they had access to necessary replenishments.[552]

This echelon structure allowed flexibility to support varying contingencies. A complete squadron could be used at one location for a particular mission, or it could be divided to address particular scenarios. In addition, RH-1 echelons could be joined with RH-2 to fulfill a mission.

Eskan Village was a complex of buildings originally constructed a few years earlier by the government of Saudi Arabia for Bedouins, who never used the facility. In an effort to remove U.S. troops from public visibility, the Saudi Arabian government encouraged them to relocate from hotels in Riyadh to Eskan Village on the outskirts of town. The village featured new facilities but, as a result of its lack of use, essentials such as pipes did not function. Civil engineers repaired and cleaned the area and readied it for troop housing. The Air Force operated field kitchens to support its troops, as well as approximately 10,000 Army personnel stationed at the complex.[553]

Encouraging a "we" approach was necessary and beneficial, especially for commanders. The 820th, 823d, and 7319th RED HORSE worked together, completing $14.7 million worth of projects during Desert Shield/Desert Storm. Col. Thomas F. Wilson, who served as commander of these Airmen, commented on the hard-working RED HORSE personnel, "if you've never been in a RED HORSE unit, the thing you find out right away is these people can outwork anybody. They can work longer, harder, and better than anybody I've seen. Anywhere." His assessment of the amount of work accomplished during Desert Shield and Desert Storm was that it "represents about three years' worth of work in four months." Colonel Wilson stressed the importance of teamwork and encouraged his personnel to look beyond their numbered units, "we're all RED HORSE,…we're really not one numbered unit, 823d, 820th, 7319th. We are a RED HORSE deployed unit and that's the way I want us to think of ourselves." This mentality was important, not just from a working standpoint; it also promoted a better quality living environment.[554]

At Shaikh Isa AB in Bahrain, the 823d completed hardstands, taxiways, and an apron spanning 600,000 square feet.[555]Maj. Timothy Bridges, who was assigned at USCENTCOM, was shocked when he visited the base, "Planes were parked so close that the Marines had put the wings up. You could just walk through and touch airplanes."[556] Additional parking areas were required at many bases to accommodate the increasing number of aircraft. Civil engineers at Shaikh Isa also erected "264 TEMPER tents, 9 latrines, 10 showers, 53 expandable shelters, 13 general purpose shelters, and 5 hangars… also furnished manpower and/or equipment for the completion of the wing headquarters building… security police armory, their own CE complex."[557]

K-Span construction was a common project for RED HORSE teams. K-Span construction at Al Kharj AB alone covered approximately 70,000 square feet of space. Other large construction efforts included a 500,000 square foot aircraft apron at Al Minhad. These large projects necessitated around-the-clock, seven-day work weeks.[558] A March 1991 After-Action Report for the 823d RED HORSE CES illustrated the variety of work completed by a RED HORSE team: "we constructed taxiways, parking aprons, munitions areas, integrated combat turn pads, trim pads, hot pit refueling pads, constructed earthen berms, erected revetments, installed aircraft barriers and approach lighting systems, built tent cities and performed engineering designs and analyses throughout the AOR."[559]

Air Force heavy equipment operators at work building a weapon storage area at a Gulf War site.

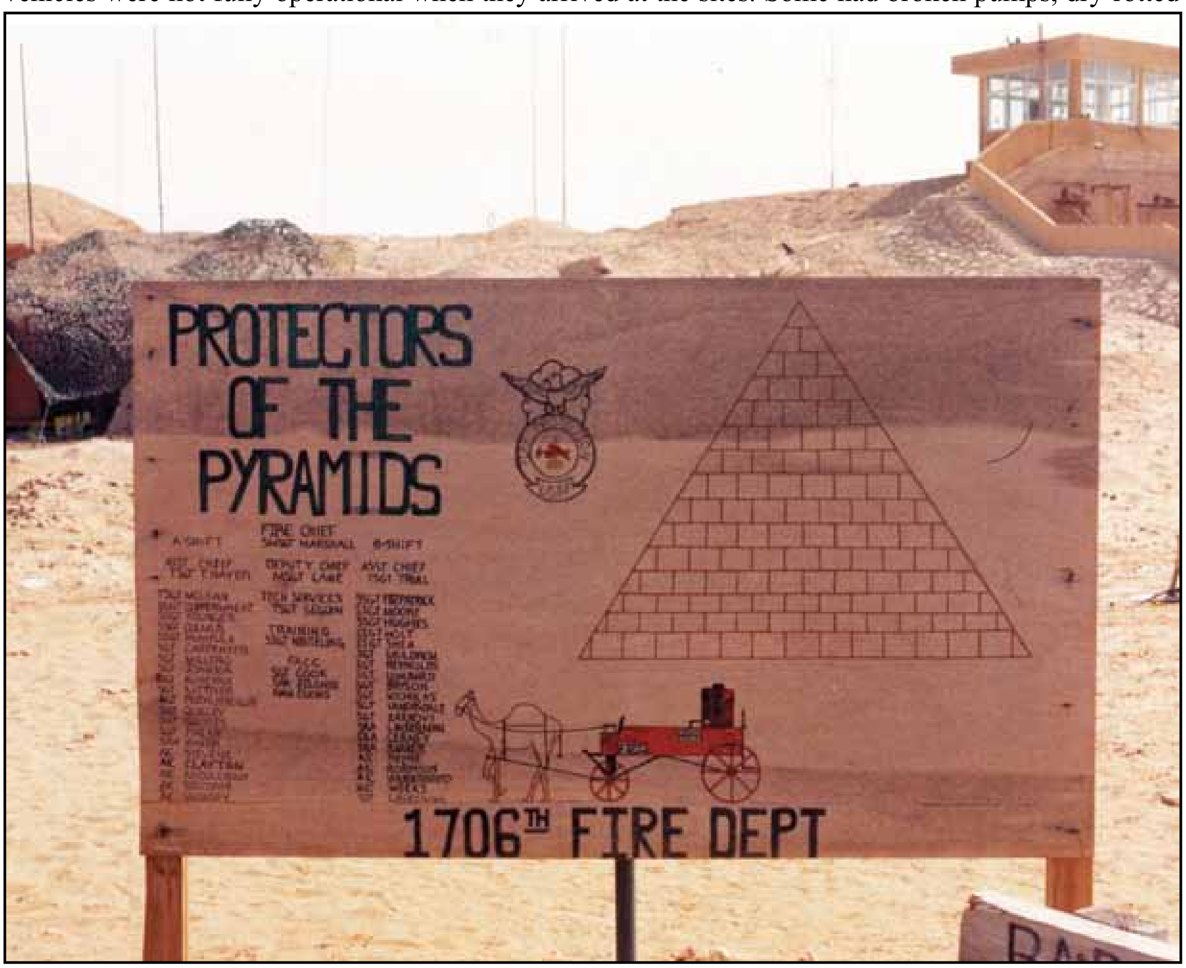
On Diego Garcia, an island in the Indian Ocean, the 351st CES Prime BEEF team from Whiteman AFB, Missouri, completed beddown operations to sustain combat teams for SAC and the Navy. They constructed more than 200 tents, provided electricity, and repaired infrastructure. Eventually, the initial general purpose tents were replaced with TEMPER tents by the Prime BEEF team and additional operations were accommodated with the construction of Expandable Shelters (EXPs).[560]

Deployed troops did not always have the equipment necessary for the construction of bases. Mobility kits sometimes were lacking all essential parts; pallets of supplies often never made it to the bare base. It was an important lesson learned by Lt. Col. Alfred B. "Barrett" Hicks, Jr, commander of the 36th CES at Bitburg AB, Germany, "do not allow your cargo to be separated from your team. An engineer is almost worthless if he doesn't have his tool box or his materials that he needs to operate with."[561] At Batman, Turkey, it was cold and rainy with deep mud when Colonel Hicks and his engineers arrived at the bare site, "There were no showers. There was no dining hall. There was no kitchen equipment for a dining hall operation. There were no personal hygiene facilities set up at the time."[562] Shortages in the arrival of complete kits resulted in 20 people bunking in tents without tent floors. The Prime BEEF team with Colonel Hicks was able to provide the basic support within seven days after their arrival.[563]

Civil engineers showed ingenuity when supplies and equipment did not arrive. Capt. Wayland H. Patterson, a key member of the CENTAF staff, related that, at King Fahd, Saudi Arabia, engineers needed gaskets to install the Harvest Falcon water system water pipe and "ended-up cutting all the grooved-pipe ends off and using plastic glue and plastic connectors to hook all those pipes up." Al Dhafra was another example of civil engineers getting the job done with limited resources. Personnel created a trim pad by "just taking the barrier cable and the aluminum stakes from their MAAS—to tie an F-16, so that they could run up the engine without having to take the engine out of the plane and find an engine stand to put it in…they could work on it while it was still sitting in the airplane." Other engineers at Bateen, UAE, made "high-voltage switch gear for their generator power plant…they took apart two SDCs, and took the bus bars out of them and made a switch gear."[564] At Masirah AB, Oman, Capt. Drew Wright and engineers from McChord AFB, Washington, and Pope Field, North Carolina, supported a base population of about 900. The host nation engineer was unable to maintain adequate water reserves in the storage tanks and asked the American forces to begin operating a reverse osmosis water purification unit (ROWPU) to help alleviate the shortage. Unfortunately, the O-rings for the ROWPU filter canisters were dry rotted from long-term storage. When unable to find replacements, Captain Wright scoured the supply warehouse and found that the brake seal O-rings for a KC-135R were a good match. The engineers installed them in the ROWPUs and soon began producing all the water needed.[565]

Firefighters were another key group that deployed during Desert Shield/Desert Storm. Firefighters were deployed to each air base to be first responders to aircraft emergencies and to protect the base from fire. They also trained with host nation firefighters and set up programs warning of fire hazards. "Basically no open flames are allowed in or around the tents," MSgt. Steve Foote of the 435th CES outlined.[566] Throughout the war, firefighters were on hand in case of emergencies during hot pit refueling operations and responded to barrier engagements, malfunctioning ordnance, and hot brake incidents.[567]

Some problems experienced by firefighters were lack of appropriate equipment and training materials. In some cases, aircraft arrived before the firefighters. Fire vehicles arrived at the sites from diverse locations. Some were in prepositioned storage in theater, some came from USAFE War Reserves Materiel storage, and one came from a base in Korea. Several weeks passed before sites received their full complement of vehicles as USCENTAF/DE attempted to spread the vehicles throughout the theater. Many of the vehicles were not fully operational when they arrived at the sites. Some had broken pumps, dry-rotted



A sign in front of the Air Force fire station at Cairo West, Egypt.

fan belts and hoses, and few tools, hoses, or firefighting agent. At Seeb, one of the prepositioning sites, the firefighters needed a P-19. Yet, they could look across the road into the prepositioning yard and see one sitting there. When they asked USCENTAF about it, they were told that it was going to another location. After several days, a C-130 aircraft landed and off-loaded a P-19 for Seeb, loaded the one from the prepositioning yard, and took it to another base.[568] For some deployed units, radio communications were nonexistent for the first two months of their deployment.[569] Vehicles often arrived without firefighting agents, but some supplies were available from the local markets.[570]

Nearly all of the sites relied upon some level of host nation firefighting assistance. In the early weeks, Air Force firefighters often shared a facility and equipment with the host nation. This was not the optimal situation, so Air Force firefighters moved into their own facility as soon as practical. The host nation capabilities varied widely among the sites. While the equipment was usually first rate, the training of the personnel was less than satisfactory in the opinion of Air Force firefighters. At a few sites, the host nation fire chief was a retired Air Force firefighter. At bases such as Taif and Jeddah, the situation was further complicated by the presence of both a host nation military and civilian fire department. This meant coordinating among three different departments and establishing common response procedures. Air Force firefighters provided countless hours of training to the host nation firefighters if the local department was needed to assist in an incident involving an American aircraft. They taught classes, showed videos, conducted walk-throughs, and drilled together. The language barrier hampered the training. Most of the host nation firefighters were third country nationals and spoke a variety of languages. In the end, most Air Force firefighters simply responded to USAF aircraft incidents and called upon the host nation if needed. USAF firefighters lacked confidence in the capabilities of the host nation firefighters.[571] Despite the lack of equipment and supplies, firefighters were routinely able to respond to emergencies and save lives. In only two months at King Khalid Military City, fire personnel responded to 1,076 emergencies and logged 4,120.5 hours.[572]

During Desert Shield/Desert Storm, Disaster Preparedness (DP) personnel provided essential services by preparing disaster preparedness plans for air bases. They advised commanders on chemical situations and planned for worst case scenarios. They also conducted routine and refresher training courses on chemical warfare defenses for deployed Air Force personnel, contractors, and host-nation civilians. However, due to limited equipment and their training schedule, DP personnel were unable to complete disaster preparedness plans at some bases.[573] DP personnel also completed inspections of the protective equipment and assisted in the storage and distribution of the chemical defense equipment.[574]

During Desert Shield/Desert Storm, EOD teams were essential for troop safety and the missions of the war. EOD personnel were deployed to oversee munitions at air bases and depots. EOD's routine missions included disposal of UXO, being on-site for flight and ground emergencies, and disarming ordnance. They also worked through such issues as equipment shortages and the lack of information regarding ordnance. Among the equipment shortages were lack of portable X-ray devices, small generators, power tools, radios, and protective shields.[575]

Prime RIBS handled housing, food, and other necessary services for U.S. Air Force troops. Prime RIBS struggled with kitchen equipment and the sandy hot environment. In many instances, kitchen equipment had to be improvised or modified. Air Force personnel ate in fixed dining facilities such as existing dining halls at seven sites. The Harvest Falcon 9-1 kitchen was the most common dining facility in the theater. Fifteen of the sites in SWA used at least one 9-1. King Fahd and Al Kharj both used four each. Thirty-two kitchens were used in SWA. The 9-1, designed for a population of 1,100, often served a greater number of people. It used TEMPER-like tent sections to construct a dining area, food preparation and serving area, and storage space. Thus, with additional kitchen equipment, it could be reconfigured or enlarged to serve above the 1,100 target population. The facility was air conditioned, however, the food preparation area, which was not designed to be air conditioned, rarely remained comfortable for the workers. The primary heat source for the Harvest Falcon kitchen was the M-2 burner unit fueled by gasoline. The M-2 burner was portable, self-contained and designed to be used inside an M-59 field range.

It was a single burner, two-tank or U-shaped tank type. The burners had to be refueled and relit outside the 9-1 for safety reasons. For sites with more than one 9-1 kitchen, this was nearly a full-time job for one person. Overall, the facility worked quite well, with only a few shortcomings. The floors quickly wore out and were replaced by linoleum or concrete. Kitchen equipment, particularly ice machines, were inadequate to handle the constantly growing requirements, but Prime RIBS personnel simply augmented the equipment. Bases procured new and larger ice machines and additional kitchen equipment such as tilt grills. They also relied on local food supplies.[576]

Another issue that Prime RIBS personnel encountered was accounting for troops that were located off-base. Hotels were commonly used; some were contracted and others were used based on verbal agreements. According to Lt. Col. Ronald P. McCoy, who was the deputy USCENTAF/DE and the senior Services officer in theater, "it wasn't surprising after the first two weeks that our first Prime RIBS [Readiness In Base Services] Teams to Riyadh, for instance, didn't have a clue who was actually in the hotels. The hotels were accepting forces based on verbal agreements, and as a result the Prime RIBS Team were in a catch-up mode trying to build a locator system. There was a lot of confusion on just who was where. You can understand that it was quite trying for our Prime RIBS folks."[577]

Prime RIBS teams also established Morale, Welfare, and Recreation (MWR) facilities at some of the bases. Requests for ballfields, gazebos, and other improvements to increase morale typically followed beddown operations. Civil engineer teams frequently created their own MWR facilities, which ranged from casual activity areas to more organized events.[578] As an additional morale enhancer, Prime RIBS created Tactical Field Exchanges. These exchanges sold candy and personal items such as toiletries. These exchanges were placed in areas where troops did not have access to a nearby city.[579]

During the early deployments, Prime RIBS created a theater mortuary operation at Dhahran Air Base. They were responsible for preparing bodies and ensuring that they were properly transferred to the Port Mortuary at Dover AFB in Delaware. In addition, Prime RIBS organized mini-morgue kits for air bases within the AOR and provided training to establish proper procedures for handling and processing human remains. This training was extended to include all U.S. military branches and some British and Saudi Arabian forces. Once the war began, mortuary responsibilities were transferred to the Army.[580]

The Mortuary Assistance Team in Dhahran and the USAFE Mortuary Processing Centers were only part of the entire Mortuary Affairs system. Before the beginning of Operation Desert Storm, remains were sent either directly from SWA to the Port Mortuary at Dover AFB or through Ramstein AB and then on to Dover. After January 17, the remains were transported from battlefield collection points to aerial ports of embarkation within SWA, and then directly to Dover by air. Once at the Port Mortuary at Dover, the operations involved the identification, processing, and shipment of remains in according to the desires of the next of kin. The Disposition Cell at HQ AFESC contacted the next of kin to determine their wishes in the disposition arrangements for the remains and personal belongings.[581]

The Dover Port Mortuary was a joint service operation, commanded during Operation Desert Shield/Desert Storm by Brig. Gen. Jimmy G. Dishner, USAF Reserve Mobilization Assistant to the Air Force Civil Engineer. Although the Air Force operated the Port Mortuary, people from all services were brought in to carry out the mission. In addition to Department of Defense personnel, the FBI sent several fingerprint experts to assist in the identification process.[582]

Initially, the facilities at the Port Mortuary were evaluated and judged too small to handle the possible number of casualties as a result of the Gulf War. Plans were made in November and December to enlarge the structure from 26,000 to 36,000 square feet. A stressed skin structure was determined as the most expeditious method of expansion and could be easily disassembled and relocated. A programming package was developed and delivered to Deputy Secretary of Defense Donald J. Atwood to use Title 10, Section 2808, Emergency Funds for the project. When completed, the facility could handle a maximum of 300 sets of remains per day. In addition, a large hangar located away from any public access was activated to receive remains directly from returning aircraft and begin the identification and processing procedures. A Harvest Eagle kitchen tent was set up to prepare meals for the personnel working at the Port Mortuary. Eight double-wide trailers were leased for offices, records management, chaplains, uniform build-up, and a break room. The Air Force leased twelve refrigerated vans for storage of human remains.[583]

One specialized area of support was provided by AFESC CEMIRT personnel. During Desert Shield/Storm, CEMIRT personnel were able to support operations by ensuring that the bare bases constructed in the AOR were supplied with reliable electric power. One problem that occurred early during the deployment was the shortage of Primary Distribution Centers (PDCs) that complicated the establishment of an efficient power distribution system at beddown locations. PDCs were a necessary and important component of the Harvest Falcon bare base electrical system. PDCs were high-voltage switch gear that distributed the power from the MEP-12 750KW generators to the Secondary Distribution Centers (SDCs), which in turn sent power through the Power Distribution Panels to the users. Operation Desert Shield caught the Air Force in the midst of a transition from Contactor Control Cubicles to PDCs. Only three PDCs were available in SWA, and the likelihood of meeting the power requirements at a growing number of sites was problematic. CONUS contractors were unable to build PDCs for the Harvest Bare kits in time, so CEMIRT was able to come through. Acting upon a USCENTAF/DE requirement for additional PDCs, CEMIRT technicians went to work and, in just a matter of days, designed a simple and reliable PDC using off-the-shelf components. They began constructing the new PDCs at Kelly AFB, Texas, at the rate of better than one per day. By September 26, CEMIRT had constructed and shipped 35 PDCs to Desert Shield sites, enabling Air Force technicians to provide critical power to the bases more efficiently.[584] CEMIRT personnel also ensured that transportable runway lighting systems reached the troops. They devised the requirements, ordered and assembled the components, and shipped them to the AOR.[585]

CEMIRT personnel also visited every in-theater location to assist civil engineer units. They proved their worth as Col. Marshall Nay, Jr., remarked, "They became the technical gurus for power generating within the AOR."[586] Troops had never seen the high voltage electrical distribution system before their deployment in the Gulf War and had set up their bases using 60kW and 100kW generators. Six CEMIRT personnel and SMSgt. Mark Larivee, an instructor for power production courses, deployed overseas to set up a depot repair capability for the MEP-12 750kW generators at Thumrait AB, Oman. This team visited nearly every site to perform maintenance, train Prime BEEF Airmen, perform emergency in-place repairs, and develop layout plans for the high-voltage systems.[587]

In November, President Bush ordered additional forces to the Persian Gulf region to provide an offensive capability. The Air Force expanded its force at several existing bases with the addition of more planes and people. When many of the sites were stretched to their maximum capacity, General Horner decided he needed more bases for U.S. forces. For Engineering and Services, this meant another push to bed down deploying forces. This time, however, Engineering and Services personnel would be in place before the additional forces arrived. Also, the presence of RED HORSE in theater to undertake major beddown tasks smoothed the process.

General Horner wanted to put more aircraft closer to the Kuwaiti border. To do this, he directed his engineers to open two new sites in Saudi Arabia. The first was about sixty miles south of Riyadh, near the town of Al Kharj. Colonel Rothenberg gave the task to a combined RED HORSE/Prime BEEF/Prime RIBS team. Colonel Rothenberg, who deployed as USCENTAF/DE, recalled "the beddown at Al Kharj was an excellent example of how RED HORSE, Prime BEEF and Prime RIBS can pool their resources to ready a bare base for a very large operational mission in a very short period of time. The site was fully operational in just 47 days—from start to reception of the last of five squadrons of fighter aircraft."[588]

Al Kharj AB: The Model Bare Base Beddown

To put more aircraft closer to the Kuwaiti border, Lt. Gen. Charles A. Horner directed his engineers to begin bedding down troops sixty miles south of Riyadh near the town of Al Kharj. The base had been programmed as a massive Saudi military installation, but only a runway, taxiway, and parking apron had been constructed. This project presented one of the biggest challenges facing Air Force engineers during the war. On November 12, 1990, RED HORSE accepted overall responsibility for construction, and personnel from the 4th Civil Engineer Squadron (CES), Seymour Johnson AFB, N.C. and other engineering personnel augmented them. After completion, the 4th CES Prime BEEF team operated and maintained the base. On November 25, RED HORSE, Prime BEEF, and contractor personnel went to work. The engineers compacted more than 200,000 cubic yards of red clay to serve as the foundation for tent city. Eventually, 630 TEMPER tents, 4 kitchens, a gymnasium, 21 latrines, and 26 shower and shave units were erected. They also constructed a sanitary system, a power plant with 17 750kW generators, assembled an air-transportable hospital, and built six K-span structures. Al Kharj was ready for aircraft in early January, and by the beginning of the war, the base was home to 4,900 Air Force personnel. Because of the successful cooperation between RED HORSE and Prime BEEF personnel and the magnitude of the work, Al Kharj became the model for bare base beddowns.[589]

Maj. Richard Norris, from the 4th CES at Seymour Johnson AFB, North Carolina, led a 100-person Prime BEEF team in Thumrait, Oman, and later in Al Kharj in Saudi Arabia. He discovered early on that some of the assets, such as the TEMPER tent and Harvest Falcon, were unknown systems to many of his personnel. Those who were trained, even briefly, became great resources in the field. They became a principal workforce, not only in assembly and construction, but they also served as trainers so others could follow suit.[590]

> When we went to Thumrait nobody had any experience, only a handful of people had any experience on a TEMPER [Tent Extendable Modular, Personnel] tent. On the Harvest Falcon assets—we had a few guys that had just come back from Field 4 training site at Eglin, a few guys that had gone over to Bright Star the previous summer. They were our core. They trained our guys, then our guys trained the maintenance guys and then it kind of blossomed from there. When we put up the first general purpose [GP] shelters, we had to pull out the TO [technical order] and it was kind of trial and error. But that was back in Thumrait. We knew how to build it by the time we got to Al Kharj. [591]

At Al Kharj, Major Norris' Prime BEEF team worked with the RED HORSE RH-1 team on construction. Together, Prime BEEF and RED HORSE erected approximately 800 TEMPER tents and multiple K-Spans to support a large cantonment area for an Air Force wing. In addition to troops, the area had to accommodate 100 fighter jets and approximately 20 airlift planes. Teams also had to establish septic tanks and electricity for the entire cantonment. According to Major Norris, the teams worked well together: "There wasn't really any competition per se between what we did and what RED HORSE did because we all did it. 'We' was RED HORSE and Prime BEEF."[592]

About the same time that Al Kharj was being constructed, another RED HORSE team was building a forward operating location only 50 miles from the Iraqi border at King Khalid Military City (KKMC). This was initially planned as a small 800-person site with limited turnaround capability for aircraft flying missions to Iraq and Kuwait. However, the base continued to expand until it reached a population of 1650 in mid-January and nearly 2000 in February. The site was extremely busy during Operation Desert Storm.

In December 1990, the Engineering and Services personnel in USAFE began to deploy to bases in Turkey—Operation PROVEN FORCE. The United States had yet to receive official approval from the Turkish government to conduct operations from their bases. However, an on-going exercise at Incirlik AB was extended and Brig. Gen. John R. Harty, USAFE/DE, sent engineers from Ramstein AB and Einsiedlerhof AS, Germany, to support the exercise and prepare for a larger deployment. The 17-member Prime BEEF team quietly worked inside a warehouse, ordered supplies, and began pre-assembling tent floors awaiting the time when the Turkish government granted approval for construction of a tent city. The floodgates were opened on January 16, and engineers, with aircraft and other support personnel, deployed to the base. The engineers constructed "Tornado Town" at Incirlik and helped bed down the deployed personnel. The base engineering operation at Incirlik was primarily contract services, so while there were few in-place military engineers, they did provide outstanding support to the deployed personnel by locating supplies and equipment.[593]

The Incirlik AB permanent party Services staff numbered only 12, thus requiring substantial augmentation to support the hundreds of troops deploying to the base. Billeting was a challenge because a noncombatant evacuation order had not been issued until after the beginning of the air war. Houses did not become available during the buildup prior to the outbreak of hostilities. Gymnasiums, professional military education classrooms, and youth association facilities were all used to house deployed personnel, prompting the construction of a tent city. The deployed personnel were fed from field kitchens in the tent city as the growing population soon overwhelmed the fixed dining facilities.[594]

A 50-person Prime BEEF team from Bitburg AB, Germany, also deployed to Batman AB, Turkey, to support a search and rescue operation. Colonel Hicks, Commander, 36th CES, Bitburg AB, Germany, was given responsibility for all support operations at Batman—an unusual, but effective organizational structure. Prime RIBS teams from six USAFE bases provided Services functions to the U.S. operation at Batman AB.[595]

Air Force Engineering and Services personnel in SWA represented only a portion of their overall role in the conflict. They also deployed to locations in Turkey, Spain, the Indian Ocean, England, Germany, France, Italy, Greece and within the United States. Some deployments were in direct support of bomber operations, while others supported tanker beddowns, hospitals, and bases that served as throughput nodes for people and materiel.

Several USAFE bases were quite busy throughout DESERT SHIELD. Both Torrejon AB, Spain, and Rhein-Main AB, Germany, were major stopover bases for personnel deploying to and from SWA. The engineers constructed a tent city at each base to handle the thousands of personnel transiting the base. Refueling capabilities were also a major concern for the engineers. Rhein-Main engineers redesigned the hydrant system enabling them to double the refueling capacity by using more trucks over a shorter distance.[596]

At the deployed locations, Engineering and Services personnel were ready when Operation DESERT STORM began. Equipment and materiel were dispersed; meals-ready-to-eat stockpiled; mini-morgues established; and, personnel and structural protection was complete. Many went out to watch the aircraft launch on their first missions. At Taif AB, Saudi Arabia, base personnel gathered in the outdoor recreation area constructed by the engineers to watch the F-111s take off. With other combat support personnel, Engineering and Services personnel manned the survivable recovery centers and damage control centers, ready to recover their base. Prime RIBS teams surged to provide food service around the clock. Firefighters went to 12-hour shifts to support coalition Air Forces. Integrated combat turns with hot pit refueling operations, required continuous fire protection. As combat sorties increased, so did the in-flight and ground emergencies, barrier engagements, and malfunctioning ordnance responses. Firefighters also extinguished fires or initiated preventive actions on armed aircraft with a variety of problems resulting from battle damage.

Members of the 820th and 823d RED HORSE teams at Al Kharj AB waiting for airlift to the Iraqi bases.

RED HORSE personnel had constructed security berms for the U.S. Army Patriot batteries at Riyadh AB, King Khalid International Airport, and near Eskan Village. They also rigged front-end loaders to assist in the reloading of the batteries, reducing the reload time from 45 to 5 minutes. In mid-January, RED HORSE formed bomb damage repair teams capable of responding from Riyadh within four-hour's notice. These teams were ready to assist the sites that needed heavy repair in case of attack. On January 17, the 820th team deployed to KKMC to complete the integrated combat turn project abandoned by the contractor. The team stayed at KKMC for several days assisting the Prime BEEF team, ready to assist other bases. RED HORSE personnel were tasked to recover Ali Al Salem AB, Kuwait, to minimal standards for C-130 traffic and to construct a tent city. This became unnecessary with the rapid collapse of the Iraqi Army. Within a few days of the beginning of the air war, it became apparent that there would be no major air attack on the sites. The greatest danger remained the possibility of chemical weapons or the occasional Scud missile.[597]

Prior to the official cease-fire, General Horner identified the task of denying two Iraqi air bases to make them unusable in the future. Colonel Wilson assigned combined RED HORSE/EOD teams; one 820th RED HORSE team was assigned to one base and two 823d RED HORSE teams to the other. They were given the task of runway denial. As Colonel Wilson described, "we used a lot of 500-pound bombs and we had to create small craters before we could create the large craters. What we tried to do was remove the runway surface from being used for landing or takeoff with other than maybe a helicopter."[598] Teams used 80,000 pounds of explosives at Tallil Air Base in southeast Iraq to create cuts every 2,000 feet within the runway and taxiway. Further southeast, the RED HORSE/EOD team completed denial at Jalibah Airfield, by creating cuts as well as craters. The damage was heavy, with craters measuring as much as 40 feet wide and 12 feet deep.[599]

By the end of Desert Shield/Desert Storm, 3,000 Air Force civil engineers had supported 55,000 troops and 1,500 aircraft through their beddown efforts at 30 locations in SWA and Europe. Prime RIBS involvement totaled 1,200 personnel providing approximately 2 million meals while also coordinating housing and providing mortuary services. Desert Shield/Desert Storm was the first trial for Prime RIBS during wartime. They successfully accomplished their duties and provided appropriate services.[600]

At the end of the war, RED HORSE teams were instrumental in dismantling materiel for return to the United States They ended their operations by March, and the 820th and 823d had all of their materiel packed up ready for transport by early May. A CES history report described the general mood of troops following the end of DESERT STORM:

> The Storm brought an end to "the mother of all wars." A cease fire was called and allied victory declared. Morale has never been so high! The civil engineers sense their return home is near and are putting forth great effort to ensure all salvageable assets are stored quickly and properly. The feeling among all is one of purpose and rejoicing. [601]

Prior to returning home, civil engineers were responsible for base cleanup. According to Lt. Col. Timothy Beally, Site Engineer for Jeddah Air Base in Saudi Arabia, "the general rule of thumb is to leave it as good as we found it."[602] Dismantling built resources was much easier and quicker than actually building them. For example, a tent that may have taken over an hour to assemble typically could be dismantled in less than half that time.

Although dismantling resources and cleaning the sites was less time consuming and less stressful than initial beddown, mechanisms were still in place to ensure efficiency and continued support. Troops still had to be fed, and cargo had to be packaged and loaded in a systematic manner. Food services personnel remained on site through the dismantling and loading process, providing hot meals. Morale was high, and many embraced a positive attitude realizing, "the sooner we get it done, the sooner we get home."[603]

The Gulf War was a major event for Air Force civil engineers. The logistics of early deployment were challenging and beddown operations proved to be demanding, but the civil engineer teams were successful. They fulfilled their missions with efficiency and maintained a resilient attitude that was contagious. They also garnered a lot of exposure. In particular, Prime RIBS created an identity for themselves, illustrating their capabilities and proving their value in the larger realm of military operations. Overall, the civil engineers learned many lessons during the Gulf War, responded superbly to the many unknowns, built even stronger teams, adapted to a variety of physical and social environments, and expanded their view of dedication. Following the end of DESERT STORM, the durability and competence of the Air Force civil engineers were tested even further and they had no time to rest before facing yet another challenge.

Operation PROVIDE COMFORT

The aftermath of the war created more work for the AF civil engineers who were involved with Operation PROVIDE COMFORT (OPC). Fleeing Iraq, 500,000 Kurds headed through the snow-covered and mountainous terrain towards Turkey. The large group of refugees was stranded without food or shelter. President George H. W. Bush agreed to provide help in April 1991. As a result, many Air Force personnel were home for only a short period of time before returning to Turkey. Lt. Col. Barrett Hicks, Jr., who had deployed from Bitburg AB, Germany, to Batman AB, Turkey, for Operation PROVEN FORCE, recounted the story of how he was chosen for OPC:

> When I left Batman, I went back to Incirlik and was waiting for a flight out, Brigadier General [Richard W.] Potter who was the JSOTF commander took me over to the Officers Club and bought me dinner one night and said, "Hicks, I want you to know that next time I go someplace you're going with me." And when he got tasked to go back down to Incirlik, as soon as he hit the ground he said, "I want Hicks back down here." So, I got a phone call at about 11:00 in the morning to be in Ramstein to get a flight out at 9:00 that night. So, that's how I found out I was going down.[604]

Other branches of the military had similar experiences, as well, as the Army, Marines, and Navy joined in the relief effort. The mission for everyone had changed from warfighting to humanitarian assistance.[605]

England, Italy, Spain, Denmark, France, and Canada also joined the effort, forming a Combined Task Force (CTF). The CTF created a three-phase approach to address the needs of the Kurdish people. Phase I included supplying the refugees with the items necessary to address the immediate issues of starvation and exposure to the weather. Phase II was the establishment of shelters in the area, and Phase III was the creation of a northern Iraq secure zone allowing Kurds to safely go back to their homes.[606]

Within one day of deployment, 27 tons of food and supplies were airdropped along the mountains. The Air Force was asked by the Army to operate bases to support military personnel and allied forces involved in the operation. Air Force civil engineers from the 564th (Ramstein) and the 36th (Bitburg) Civil Engineering Squadrons quickly began building a camp on a flat piece of land located in Silopi, Turkey, just eight miles from the border with Iraq. The site was chosen because of its level terrain which allowed for easier and more efficient construction and accommodated aircraft; access to nearby water; and, close proximity to Iraq. Prime RIBS teams arrived to offer food service, housing, and mortuary services. Kitchen facilities were supervised by the Air Force, but in some cases they were operated by the Army. Working in a combined services environment and accommodating large numbers of transient troops made it nearly impossible to estimate how many personnel required food on a daily basis. Troops traveled from base to base and to and from refugee camps. Eventually, Services worked together to ready the necessary supplies and they aptly supported the troops providing aid to the Kurds.[607]

The camp was initially planned to hold 500-700 personnel assisting with the relief effort, but the population soared as a result of the additional forces. The area was eventually designated as a Humanitarian Service Support Base (HSSB). Capt. Donald Gleason, who served as head of combat services support reported, "we constructed billeting, laundry, latrine, recreation, office, mortuary, and equipment storage/maintenance areas for those forces." It took Air Force civil engineers only two weeks to create a base for more than 4,000 multi-national troops. Capt. Darren Daniels, the OIC for the 36th CES Prime BEEF team, rightfully bragged about his troops and their work on the camp, "not a bad effort for a team that was sized to support a 500-750 man beddown operation." Captain Daniels' Prime BEEF team members worked particularly well together because of their previous six months in Batman, Turkey, supporting Operation Proven Force. According to Captain Daniels, "approximately 60 percent of the same individuals redeployed due to the short notice and team spirit they had developed at Batman."[608]

OPC I lasted from April through July 24, 1991, then OPC II began. Air Force civil engineers continued their efforts even after the last Kurdish border camp closed in June. Prime BEEF teams from Ramstein, Germany, and Torrejon, Spain, remained in Silopi to transform the original HSSB into an air conditioned Harvest Falcon facility and to construct wash racks and other ancillary support resources to aid future deployments. The main mission of OPC II was to maintain a presence of troops along the border of Iraq to dissuade further aggression from Saddam Hussein.[609]

OPC III required the repair and renovation of Sirsenk airfield in Iraq. Captain Daniels' Prime BEEF teams were deployed to Sirsenk and became the first Prime BEEF personnel to enter Iraq. Sirsenk airfield originally was planned as a private airport for Saddam Hussein during Desert Storm, but was eventually bombed and cratered by coalition forces flying over northern Iraq. The Prime BEEF teams worked alongside the Navy Seabees and the Army on runway repair and UXO retrieval. According to one sergeant who participated in the effort, "it really put our wartime training to test as we cleared the UXOs and helped repair the runway for C-130 operations." Combat Support Commander, Colonel Hicks illustrated his pride in the Prime BEEF troops stating, "we rewrote the book for Prime BEEF team support…normally we operate from air bases a safe distance from the front lines. But this time we marched into Iraq immediately behind the Marines. We even reconnoitered the Sirsenk airfield before the area was secured by the coalition forces." Air Force civil engineers also bedded down 800 troops near the airfield using Harvest Falcon assets.[610]

For civil engineers, a significant lesson learned during OPC was the importance of combined and joint operations. These operations allowed troops to learn from the capabilities of others. This was particularly beneficial for the Prime BEEF and Prime RIBS teams, who were relatively unknown in the larger circle of the U.S. and foreign militaries. Colonel Hicks, who served as the Director of Services at Silopi during Operation Provide Comfort, discussed the challenges involved in working with others who did not realize the capabilities of his teams, "we worked real hard to build a good strong relationship with…the Army and the Marines at Silopi…we really had problems working with the Army. It's true. They don't know what we do. They didn't have the slightest idea of what Prime BEEF is all about." Colonel Hicks recounted a visit from an Army commander that illustrated the situation,

> Brigadier General [Harold] Burch, who was the Combined Support Command Commander at Silopi, came over here and visited us not too many weeks ago when he brought a plate as a presentation to us. He said, "When I got to Silopi, they started talking about Prime BEEF. I thought that was something they were going to serve me for dinner. Then when they started talking about Prime RIBS I thought, My goodness, we're going to have a really good meal now!" He had no understanding of what the capabilities of the Air Force engineers are.[611]

The Gulf War and OPC allowed Prime BEEF and Prime RIBS personnel to introduce themselves to many military personnel who were unaware of their capabilities. They were not only celebrated as successful, but were also recognized as a necessity.

Operation Pacific Haven

On September 15, 1996, a Joint Task Force (JTF) was created to evacuate 6,600 Kurds that had fled Iraq and Turkey to Guam. Each branch of the military was involved in the humanitarian effort termed Operation Pacific Haven. The geographic location of the small island, as well as the potential for typhoons precluded the use of tents for housing. As a result, a housing area located at Andersen AFB, near the center of the island, was used as a temporary facility. The 36th CES was responsible for assessing the base housing to ensure livability. In addition to the Air Force civil engineers, Navy and Coast Guard personnel, as well as personnel from Andersen AFB, aided in the effort to repair, clean, and stock the housing. Components from four field kitchens were combined to create a feeding facility. The kitchen was supplied with electricity and water lines installed by the combined forces of the Air Force and the Navy. In addition to housing and feeding, priorities included medical support. An Air Transportable Hospital was relocated by the 374th Air Wing from Yokota AB in Japan. A C-130 transferring temporary clinic resources and 46 personnel arrived September 17. Tents were built to support the clinic and a house on base was used for critical cases.[612]

In addition to supporting the immediate needs of the evacuees, the JTF had to arrange processing prior to offering a safe haven. Offices were created within existing dormitories on base. A school was built to offer instructions on the basics of living in the United States, as well as the essentials of the English language. Andersen AFB engineers along with the Navy Seabees constructed two mosques within two days, following Muslim traditions. Eventually, additional comforts were added to the area, and including a community center and an exchange. In order to relieve Services personnel, a self-feeding program for the Kurds was established permitting them to acquire provisions and cook meals in their makeshift homes. This freed up personnel and allowed them to improve quarters maintained for the military and civilian workforce. Laundry facilities were enhanced and MWR conveniences were provided.[613]

Immigration and Naturalization Services personnel interviewed and processed the evacuees for relocation to the United States where they were granted asylum. Operation Pacific Haven concluded in April 1997. The operation allowed engineers to illustrate their ingenuity and efficiency through their ability to coordinate housing, feeding, medical support, and additional facilities within a short period of time. In addition, Operation Pacific Haven demonstrated the ability of each military branch to work together as a JTF.[614]

Other Military Deployments

Khobar Towers, Saudi Arabia

U.S. Airmen remained in Saudi Arabia after the end of Operation Desert Storm to enforce no-fly operations over southern Iraq. It began in 1992 and was known as Operation Southern Watch. Many Airmen lived in dormitories in Dhahran, Saudi Arabia, as part of a complex known as Khobar Towers. On June 25, 1996, a bomb exploded outside one tower. The bomb was fixed to a fuel truck parked next to the perimeter fence. The U.S. and Saudi guards had little time to warn personnel to evacuate the eight-story building.[615] Lt. Col. Robbin Schellhous described the extent of destruction, "The CE dorm….was in shambles. Every window was shattered, with many window and door frames blown completely out of their openings."[616] The force of the blast embedded the window glass in the concrete walls and metal door knobs. Nineteen Air Force personnel died in the blast at Khobar Towers, including Airman First Class Christopher B. Lester, a Power Production Specialist for the 88th CES, Wright-Patterson AFB, Ohio. More than 300 people were wounded. Civil engineer personnel began recovery operations immediately. Contractors cleaned and repaired the damaged dormitories while civil engineers implemented greater physical security measures, including shatter-proof glass and extending the perimeters around the base.[617] The Air Force completed two investigations into the security and protection of Khobar Towers based on an earlier study by Army Gen. Wayne Downing. As a result of the bombings and investigations, the Air Force implemented stronger force protection techniques. Sheila E. Widnall, Secretary of the Air Force, stated, "What we learned in the aftermath

An overall view of the north side of the building that was severely bomb damaged in the Khobar Towers complex, 1996.

of the Khobar Towers bombing and from our review of the facts and circumstances surrounding it has drastically altered the way the Air Force thinks about, prepares for and defends against threats to the safety of our forces."[618]

After the Khobar Towers bombing and subsequent investigations, personnel were relocated to Prince Sultan Air Base at Al Kharj, Saudi Arabia. The 823d RED HORSE constructed a bare base with Harvest Falcon assets: four housekeeping sets, one industrial set, and flightline facilities.[619] The 823d RED HORSE also constructed a road and guard towers around the perimeter to facilitate force protection. The new air base implemented all of the force protection measures and directives from General Downing's report. Permanent construction was completed by Saudi Arabian contractors and replaced the temporary tent cities erected by RED HORSE personnel.

The bombing of Khobar Towers provided the impetus for re-integrating Force Protection (FP) measures into Air Force contingency and deployment planning. Force Protection also extended to antiterrorism and counterterrorism measures. Air Force civil engineers followed the Force Protection Plan developed by the commander and FP Working Group for base construction in contingency operations. The FP Plan comprised "site layout, barrier placement, berm construction, security lighting, backup power, water source protection, expedient hardening, and terrain modification."[620] Air Force civil engineers also adopted Passive Force Protection measures that included hardening facilities and aircraft shelters, constructing fences and berms, and implementing camouflage, concealment, and deception tactics.[621]

In 1997, a new group was formed. The 820th Security Forces Group was established at Lackland AFB, Texas. The 80-member group comprised specialists in the fields of security, combat arms training and maintenance, civil engineering, communications, intelligence, logistics and supply, medical, personnel, and transportation. Civil engineers assigned to the group included one engineering craftsman, three EOD, and two readiness personnel. The purpose of the group was to provide force protection for the AEFs, and to establish and to implement effective FP procedures for installations around the world.[622]

Military Operations Other Than War

Military operations other than war (MOOTW) were focused

> on deterring war, resolving conflict, promoting peace, and supporting civil authorities in response to domestic crises…MOOTW may involve elements of both combat and noncombat operations in peacetime, conflict, and war situations. MOOTW involving combat, such as peace enforcement, may have many of the same characteristics of war, including active combat operations and employment of most combat capabilities. However, MOOTW are more sensitive to such considerations due to the overriding goal to prevent, preempt, or limit potential hostilities. In MOOTW, political considerations permeate all levels and the military may not be the primary player.[623]

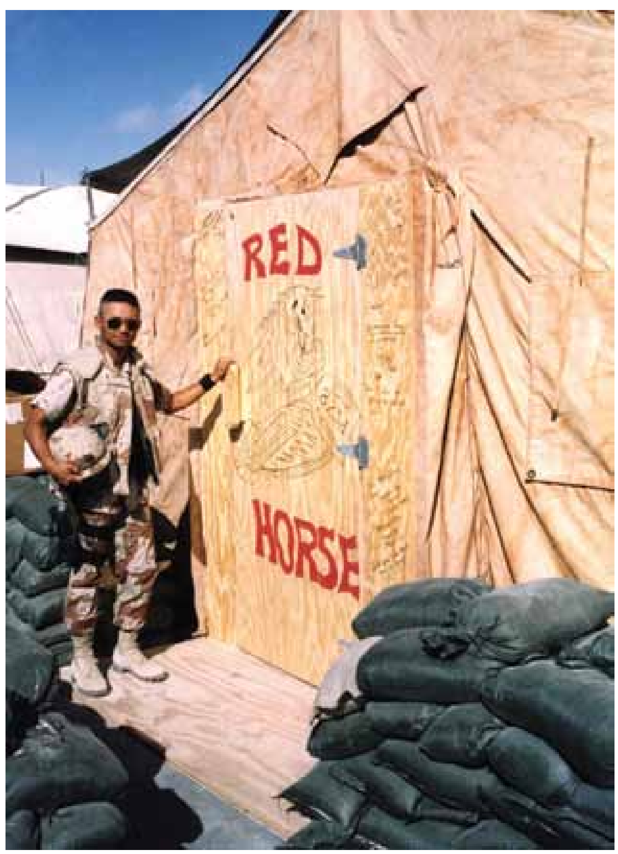
Typically MOOTW deployments were international, but not always. They could last a short period of time or be of long duration.[624] Representative types of MOOTW included enforcement of sanctions, enforcing exclusion zones, protection of shipping, combating terrorism, counterdrug operations, ensuring freedom of navigation, noncombatant evacuation, peace operations, recovery operations, arms control support, domestic support operations, foreign humanitarian assistance, nation assistance, show of force, and support of insurgency.[625] Sometimes the lines between war combat situations and MOOTW were blurred. After a war situation ended, deployments sometimes evolved into MOOTW. For example, Desert Storm was followed by several MOOTW deployments, such as Operation Provide Comfort and Operation Southern Watch. Other MOOTW assignments occurred in such places as Somalia, Haiti, and the Balkans.

Somalia

In December 1992, President George H. W. Bush announced that the United States was contributing forces to help stabilize the increasingly horrific civil war in Somalia. During the 1980s, Somalia was a defense partner with the United States and allowed the U.S. Navy access to ports and airfields. By the end of the 1980s, civil war raged in Somalia and images of starving people were prevalent on U.S. television screens. Under increasing pressure to do something, President Bush pledged that the mission was confined to opening supply lines, delivering food to the people in the embattled region, and preparing the way for UN peacekeepers in Operation Restore Hope.[626]

Air Force civil engineers were among the first U.S. troops deployed. In early November 1992, 11 members of the 823d RED HORSE were deployed to Mombasa, Kenya. This initial deployment to Kenya focused on analyzing available airfields in Kenya and Somalia. The data were needed to determine operability of airfields and potential repairs required to support the anticipated traffic of C-130 aircraft. The 11-man crew also helped identify aerial ports of entry at Mogadishu, Kisamayu, and Baledogle to receive increased numbers of troops. At Baledogle, Air Force civil engineers worked to prepare the area for the arrival of the Army's 10th Mountain Division by establishing and repairing a 6,000-foot by 140-foot runway with parallel taxiway in three days.[627]

An additional 83 personnel were deployed on December 17, 1992 to assist 200 Air Force personnel assigned to man the operations control center at Mogadishu and another 200 personnel stationed at the U.S. embassy compound. These 400 persons were housed in substandard quarters. RED HORSE was tasked to ship Harvest Falcon assets stored in Saudi Arabia and to install them in Mogadishu. On a site prepared by Navy SeaBees, RED HORSE personnel erected TEMPER tents, installed power and air conditioners, installed a latrine and shower unit, set up a mobile kitchen, constructed a perimeter road, and installed miles of perimeter concertina wire fencing. Preparation of the site also included



Capt. Efren V.M . Garcia led the team from the 823d RED HORSE Squadron to Mogadishu Airport, Somalia.

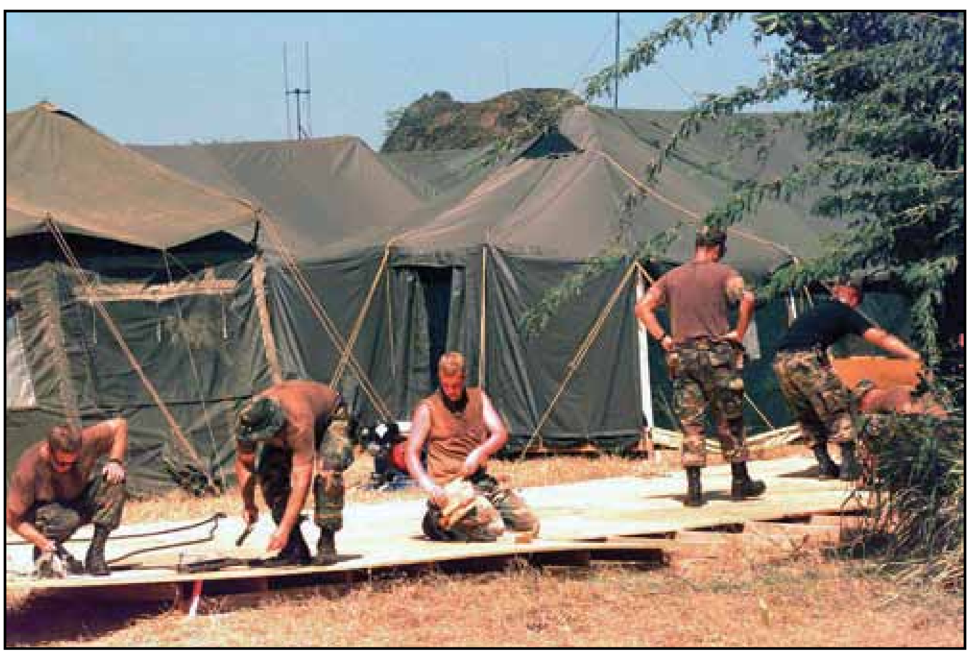
removal of derelict aircraft and old ordnance. In addition, RED HORSE installed a reverse osmosis water purification system that transformed water from the Indian Ocean into a steady potable water supply. Between November 1992 and March 1993, up to 101 personnel of the 823d RED HORSE were deployed to support operation RESTORE HOPE. When beddown activities were completed, the RED HORSE personnel turned the facilities over to the Prime BEEF team deployed from Dover AFB, Delaware.[628]

Between September and November 1993, another 19-member team from the 823d RED HORSE was deployed to Mogadishu. This group provided force protection for Air Force ground support equipment and Army aviation assets. Its primary task was to build bin-type revetments to protect Air Force ground equipment and Army helicopters. The team installed metal-panel revetments from kits into box-shaped segments around the assets needing protection. The working conditions were hostile and included periods of being under fire from small arms and rocket-propelled grenades.[629]

During 1993, President Clinton modified the U.S. military mission in Somalia from humanitarian assistance to nation building by disarming local militias and trying to capture a noted war lord. In October 1993, a gun battle in downtown Mogadishu resulted in U.S. and civilian casualties. The United States was humiliated by images of a killed U.S. soldier being dragged through the streets. President Clinton announced a troop withdrawal by the end of March 1994. As a result of that experience in Somalia, the United States became reluctant to intervene in other armed humanitarian interventions, which strained relations with the UN.[630]

Haiti

On September 29, 1991, elected Haitian president Jean-Bertrand Aristide was forced into exile by Lt. Gen. Raul Cedras. Aristide had only been in office since February after decades of dictatorship. One week later, President George H.W. Bush suspended foreign assistance to Haiti, prohibited U.S. companies to make payments to the de facto regime, and froze its financial assets. An international trade embargo was next imposed on Haiti at the insistence of the Organization of American States (OAS). As a consequence, the financial stress coupled with political violence led to an exodus of Haitian refugees.[631]



Carpenters from the 820th RED HORSE Squadron, Nellis AFB, Nevada, put together a hard wood floor for a future tent location in Port au Prince, Haiti in support of Operation Uphold Democracy, 1994.

The UN and the OAS condemned the coup and applied economic sanctions. In July 1994, the UN Security Council gave President Clinton authorization to lead an intervention into Haiti. President Clinton sent 20,000 troops into Haiti in September 1994.[632] As the force approached Haiti, Haitian military officials relented and agreed to step down after former President James Carter's negotiations. President Clinton's military operation instead became a humanitarian operation, known as Operation UPHOLD DEMOCRACY.[633] The continuous airlifts provided vital food and support to refugees. The 820th RED HORSE Squadron assisted in the operation by constructing bare base camps for 1,500 deployed military personnel and repairing transportation routes in 1994. Camps were constructed using 334 tons of Harvest Eagle assets.[634]

Concurrently, the 820th RED HORSE Squadron aided in another related endeavor, Operation SEA SIGNAL. The operation was another joint task force designed to stop the flow of illegal immigrants into the United States. Navy and Coast Guard personnel intercepted the Haitian and Cuban refugees and transported them to a refugee camp at Guantanamo Bay. RED HORSE constructed camps for relief workers and military personnel as well as assisting Seabees with construction of the refugee camps for approximately 50,000 refugees.[635] In 1995, a RED HORSE advanced echelon unit deployed to Haiti to support efforts in planning designs for long-range projects.[636] On April 17, 1996, Operation UPHOLD DEMOCRACY concluded.[637]

Balkans and Kosovo

By the beginning of the 1990s, ethnic tensions in the country of Yugoslavia escalated and resulted in civil war. Former provinces declared independence from the central government, but Slobodan Milosevic, then President of Yugoslavia, was determined to retain control by force. While NATO, the European Union, and the United States watched, the former Yugoslavia disintegrated and the subsequent civil war resulted in ethnic cleansing in Croatia, Bosnia, and Herzegovina. The European Union proposed a peace plan in 1993, but did not gain U.S. support. After the Serbs shelled 70 Bosnians in the marketplace in Sarajevo in February 1994, the United States sponsored a diplomatic mission to negotiate peace with President Milosevic. When the U.S.-led diplomatic mission failed, NATO launched air strikes against Bosnian Serb military targets beginning August 30, 1995 and lasting 11 days. In all, 3,515 sorties were flown, with the United States flying 2,319 (65.9 percent) of them. The air strikes brought President Milosevic to participate in peace talks among the Serbians, Bosnians, and Croats at Wright-Patterson AFB in Dayton, Ohio, in November 1995.[638] The Dayton Peace Accords ending three years of fighting in Bosnia was signed in Paris on December 14, 1995.

Allied forces, including the United States, Russia, and 10 other nations, shared in Operation JOINT ENDEAVOR to keep the peace in Bosnia beginning in late December 1995. The United States committed 20,000 soldiers to Task Force Eagle. The Air Force Air Mobility Command (AMC) flew 3,000 missions, ferrying 15,600 troops and 30,100 short tons of cargo to the region. The airfield at Tuzla in Bosnia-Herzegovina served as the primary port of entry.[639] Air Force civil engineers from AMC and USAFE deployed to Tuzla AB, Bosnia; Taszar AB, Hungary; and, several other locations to support tanker airlift control element operations. Air Force civil engineer support included specialists in airfield lighting, EOD, firefighting, airfield pavements, and snow removal.[640]

EOD personnel were deployed early to protect personnel by eliminating or reducing threats posed by U.S. and foreign ordnance, such as randomly deployed mines, improvised explosive devices, and unexploded ordnance. Many occupied airfields used by Allied forces had been mined. Tuzla AB had been mined three times since 1960, and 3,000 mines were estimated to still be in place within the fence line of the air base. EOD personnel in deployment situations provided education about unexploded ordnance, supported aircraft launch and recovery during all scheduled flights, cleared areas for airfield repair/expansion, removed recovered unexploded ordnance recovery, analyzed and neutralized improvised explosive devices, provided very important person protective security, and collected and

The 823d RED HORSE Squadron, Hurlburt Field, Florida, builds a tent city at Tuzla Air Base, Bosnia-Herzegovina.

disposed of hazardous souvenirs collected by deployed personnel.[641] By fall 1996, EOD technicians from the 4100th Group (Provisional) assigned to Tuzla AB had conducted nearly 350 operations and destroyed 475 pieces of ordnance.[642]

The 823d RED HORSE from Hurlburt Field, Florida, was deployed starting December 15, 1995, not to restore and expand an airfield in Bosnia as originally planned, but to bed down the Army in a tent camp at Tuzla AB. Although Col. Susanne Waylett, unit commander, had been informed that RED HORSE was not needed to support the strategic airlift, she sent an advance team to inventory RED HORSE equipment stationed in Italy and a second team to Ramstein AB, Germany, with instructions to be prepared to order materials. When the formal tasking arrived for the unit to deploy, the advance elements were in place. The first team of RED HORSE (RH-1) deployed immediately, followed by 227 people with equipment. All deployed Air Force personnel headed to Bosnia were required to complete three days of training in Germany in cold weather survival, mine awareness, and laws of armed conflict. While in Germany, the team repalletized its cargo for airlift into Bosnia and began ordering supplies. RH-1 reached Tuzla on December 24, 1995 and found Army troops living in crowded conditions. RH-1 members began to build tents for themselves and their incoming unit, as well as tents for Army personnel. RED HORSE averaged construction of 20 hardback GP medium tents per day to house 1,650 personnel at what became known as Tuzla Main. RED HORSE constructed three other tent cities using the Army's Force Provider beddown equipment and hardback tents. In all, the four tent cities accommodated 5,000 personnel.[643]

Colonel Waylett well remembered her time commanding the RED HORSE unit assigned to Bosnia. After the tasking came through to build three tent cities to support 5,500 Army personnel, Colonel Waylett met with Army representatives in Europe and found that requirements for the beddown were ill-defined, the sites were not selected, and the time frames were unrealistic. The Army's plans did not account for "the rules of doing beddown, like setting priorities for resources, setting priorities for equipment, working together, doing this before that and that. When you select a site, you evaluate

823d RED HORSE Squadron commander Col. Susanne Waylett in Bosnia during Operation JOINT ENDEAVOR with Navy Admiral Leighton Smith (right), commander of Allied Forces Southern Europe.

things like drainage, power supply, water supply. We had that experience; they didn't."[644] But the Army personnel on the ground were grateful to the RED HORSE for bedding them down. Colonel Waylett recalled,

> the gratification for that job came from the young soldiers that you met walking down the road in the mud at Tuzla. They would stop you and say, "Thank you. We know you're building these for us, and it's great." And we were criticized when we came back, by some of the Army engineers in some higher places, for providing a standard of living that was excessive. We provided the standard that we're used to providing. That was an experience of a lifetime.[645]

A Prime BEEF team from the 52d CES, Spangdahlem AB, Germany, was deployed to Tuzla AB to operate and maintain the base beginning in late December 1995. The team comprised personnel with a variety of specialties, including heavy equipment operators, electricians, plumbers, and airfield lighting. Snow removal from the runways was particularly important during the winter when 18 inches of snow fell in 12 hours. The Prime BEEF team was able to keep Tuzla AB operational when other airports had to shut down. At the end of its deployment, the Prime BEEF team turned over most of the base operations and maintenance to a U.S. contractor.[646]

Fire protection for the Tuzla AB was provided by a team of firefighters deployed from the 100th CES fire department, Royal Air Force Mildenhall, Great Britain. Three members of the team arrived on December 11, followed by 9 other team members, who arrived on December 22. The first team unloaded its fire truck in six minutes, filled it with water, and was ready to start its duties the same night it arrived. Deployed firefighters were always on standby near the runway while aircraft were flying. The team also installed smoke detectors in all facilities and tents, as well as educated all personnel stationed at the base on fire safety and evacuation procedures.[647]

As Operation Joint Endeavor continued, Air Force civil engineers rotated through air bases. Air National Guard and Reserves were integrated with active duty personnel to sustain 24-hour operations at Taszar AB, Hungary, during 1997. Civil engineer personnel were deployed in 120-day rotations to support the Army's capability to receive and deploy cargo and personnel and medical evacuation airlifts as needed.[648]

In spring and summer 1998, fighting erupted between the Serbs and the ethnic Albanians in the province of Kosovo. In September, the UN demanded a cease-fire and the removal of Serbian troops. In October 1998, under the threat of NATO air strikes, the Serbs agreed to discontinue their attack. The cease fire held until January 1999, when fighting resumed. Peace negotiations ended in late February without agreement. During March 1999, Serbian armed forces began the removal of ethnic Albanian citizens of Kosovo who were primarily of Muslim heritage. Citizens were expelled from their homes and told to leave the province. Many ethnic Albanians were killed, and homes were looted and burned. NATO responded with air strikes to subdue Slobodan Milosevic's forces. Operation Noble Anvil, the U.S. contribution to the overall NATO effort called Operation Allied Force, began on March 24, 1999 when B-2 and B-52 missions were launched to strike at Serbian military command and control stations. In addition to Air Force missions, the U.S. Navy launched Tomahawk land-attack missiles. Air strikes continued until June 10, using nearly 1,300 aircraft contributed by 13 countries. The United States contributed nearly two-thirds of the aircraft, which came from all four services. U.S. aircraft flew from 28 bases in 11 countries. On June 9, 1999, a military technical agreement was signed to end the conflict. Yugoslav armed forces were given 11 days to withdraw from Kosovo. The withdrawal was monitored by British, French, and U.S. forces.[649]

Air Force civil engineers were involved in the effort by February 1999 when AFCESA's Airfield Pavements Evaluation team started to receive requests for copies of pavement evaluations completed in 1995 during NATO Operation Joint Endeavor. They were also asked to conduct airfield pavement evaluations for locations in Albania. By April, airfield pavement specialists from AFCESA were deployed to Europe to conduct tests at numerous airfields in Slovenia, Belgium, Germany, Hungary, France, Italy, Albania, and Macedonia. In all, 17 airfields in 10 countries were analyzed during April and May 1999. The testing program both assessed the structure and determined the load-bearing capacity of runway, taxiway, and apron pavements to support aircraft, especially heavy cargo planes. The baseline data documented runway conditions prior to use by NATO to determine necessary repairs prior to returning to host countries.[650]

CEMIRT, also part of AFCESA, was tasked to train deploying civil engineer personnel on the operation and maintenance of 750-megawatt power generators. CEMIRT supported USAFE to acquire hydraulic power units for the mobile aircraft arresting systems placed on bases throughout Europe. CEMIRT worked with USAFE to maximize its purchases by researching information on expeditionary airfield lighting systems and construction information for helicopter pads. CEMIRT also provided cost estimates for installation of lightweight Fairlead beams to support the mobile aircraft arresting systems.[651]

Throughout USAFE, civil engineers began to plan for a substantial increase of deployed aircraft and troops for two major operations: the air campaign known as Operation Noble Anvil and a humanitarian effort to support Kosovar refugees in Albania known as Shining Hope. The first challenge was to identify operating bases. In the past, USAFE had main operating bases and collocated operating bases to handle overflow during wartime, but the number of bases in USAFE was drawn down to six main operating bases and 80 geographically separated units. Operating bases had to be identified, assessed,

Members of the 52d CES, Spangdahlem AB, Germany, assemble a Harvest Eagle shower/wastewater distribution pump for a tent city at Aviano AB, Italy.

and evaluated for use, and permission for use from host nations was required. Then the bases had to be prepared to receive incoming aircraft and personnel. Civil engineers were vital to bedding down incoming aircraft and troops and sustaining the bases during the action. In all, more than 900 civil engineer personnel were deployed to 20 locations on two continents.[652] These included members of both Prime BEEF and RED HORSE teams. Specialists included liquid fuels maintenance engineers to maintain the liquid fuel systems used to fuel aircraft, runway maintenance personnel to keep runways operational and free from foreign objects to prevent damage to aircraft, electricians to maintain airfield lighting systems 24 hours per day, and power production troops to maintain electricity and to repair aircraft arresting barriers and mobile arresting systems. Seventy firefighters with 10 aircraft rescue firefighting vehicles were deployed to 11 locations. EOD specialists worked extended hours to keep deployed personnel and aircraft safe from explosives hazards.[653]

Aviano AB, Italy became the primary launching base in the air campaign. In February 1999, at Aviano AB, the 31st Civil Engineer Squadron began construction of a tent city named Caserma Barbarisi to house up to 4,000 additional Air Force personnel deployed to support their aircraft. Assisted by civil engineer teams deployed from Ramstein AB and Spangdahlem AB in Germany, Air Force civil engineers erected more than 200 tents and a dining facility in less than one week. Air Force civil engineers also electrified the tent city, erected an electric substation, and resurfaced six aircraft parking pads.[654] Another project completed by the civil engineers was renovation of an Italian dormitory in the flightline support area to accommodate 600 additional personnel. Twelve electricians, power production specialists, and equipment operators from the 823d RED HORSE Squadron from Hurlburt Field, Florida, deployed to Aviano AB to install primary electric cable, three electric substations, three secondary distribution lines with 27 power panels, and 224 air conditioning units.[655] Other projects completed at Aviano AB included construction of a permanent boiler facility with a 1,000-gallon water heater, office renovations, and erection of a troop support area in the tent city.[656]

At Tirana, Albania, Rinas Airport was transformed into an air base. The airport was selected as a major hub to receive and transship humanitarian supplies for Kosovar refugees as part of JTF Shining Hope. On April 4, 1999, 7 members of an advance Prime BEEF team from the 86th Civil Engineer Group from Ramstein AB, Germany, deployed to Tirana. Their mission was to bed down operations at the airport, to erect Harvest Eagle kits to accommodate 400 Air Force personnel near the flightline, and to bed down Army personnel as part of JTF Hawk. In four-and-a-half days, the civil engineers constructed a tent city that typically required 10 days to construct. Followed by 98 additional personnel who arrived on April 7, the Prime BEEF team built-up a muddy former soccer field on which to erect more than 100 TEMPER tents using Harvest Eagle assets. Construction proceeded despite days of heavy rain. Completed by April 30, a detachment of 36 Prime BEEF personnel remained to sustain the base and continued to improve the living conditions.[657]

For Operation Noble Anvil, the RED HORSE adopted a "hub and spoke" organization. The 823d and 820th RED HORSE squadrons were deployed to Ramstein AB, Germany. From there, advanced teams were sent to air bases to assess what manpower and equipment was required to make the bases operational. The RED HORSE contingent stationed at Camp Darby, Italy, where the pre-positioned RED HORSE equipment was located was then able to ship the appropriate equipment as required. Larger RED HORSE teams were deployed to complete the work and then redeployed to complete other tasks.[658] By the end of the campaign, the 823d RED HORSE had deployed 229 personnel to operate in seven sites in five countries.[659]

Eight members of the 823d RED HORSE deployed to Tirana on April 16, 1999, followed by an additional 94 members. By early July, the RED HORSE team worked on the following projects: replaced failing airfield ramp and constructed new parking pavement, built a new 987-ft concrete taxiway, built a cargo storage area, repaired and repaved a three-mile perimeter road, constructed a medical evacuation helicopter pad, upgraded the electric power grid to the tent city, and constructed fuel pads. Eighty-one members of the 820th RED HORSE from Nellis AFB, Nevada, were deployed to Tirana on June 8 to support in-theater civil engineer activities. The 820th completed the concrete taxiway at Tirana AB, repaired roads and bridges, and constructed a school in Albania.[660]

At Taszar, Hungary, a RED HORSE team was tasked to evaluate airfield repairs and upgrades necessary to accommodate three squadrons of Marine Corps F-18 Hornets and one squadron of A-10 Warthogs. The taxiway at the airfield was almost non-operational and required milling and installation of a 3-inch asphalt lift. Heavy equipment was required immediately; assets were borrowed from an existing camp in Bosnia and arrived in an Army convoy. By the end of the project, the RED HORSE team had milled and overlayed with asphalt 80,000 square meters of taxiway, constructed a cargo area for ammunition supplies, and constructed a 100 x100-ft radar approach control pad.[661]

A 40-person RED HORSE team set up two Harvest Falcon sets at Balikesir AB, Turkey, to bed down three F-15 Eagle squadrons.[662] Given 21 days to erect a tent city for 2,200 persons, the RED HORSE team was deployed from Ramstein AB, Germany. Equipment was leased in Turkey using the AFCAP program. The first Harvest Falcon assets arrived May 31, 1999. With the help of a bare base team from the 49th Materiel Maintenance Squadron, Holloman AFB, New Mexico, the beddown was completed on June 7, 1999, two weeks ahead of schedule.[663]

Engineers from the 823d RED HORSE Squadron move dirt at Rinas Airport, Tirana, Albania, during Operation ALLIED FORCE, 1999.

During March 1999, AFCESA staff and Air Force readiness planners began discussions about constructing and maintaining a refugee camp. The U.S. State Department reported that 560,000 Kosovars had fled their homes and become refugees in neighboring countries. Using AFCAP as a funding vehicle, the AFCAP contractor RMS L.C. was directed in early April to prepare estimates to construct and to maintain a refugee camp for 10,000 persons with expansion to accommodate 20,000. By mid-April, the decision was made to contract with the private sector to construct the refugee camp. The Air Force issued "execute orders" through AFCAP on April 22, 1999; official notice to proceed was issued on April 26, 1999 to build a refugee camp to accommodate 20,000. Tents to shelter 2,500 refugees were required by May 12, 1999.[664]

RMS, L.C., was supported by subcontractors Bechtel National, Inc., Lockwood-Greene Technologies, International American Products, Inc., and Fritz Government Services.[665] By April 26, 1999, the final site for the camp was selected, two RMS staffers were on site, and 453 military tents were in transit from Italy to the Albanian port of entry at Durres. These tents previously were used at a tent city at the Prince Sultan Air Base, Saudi Arabia.[666] Air Force EOD certified the camp site clear of ordnance on May 1, 1999 and the initial shipment of tents arrived. The first tents were erected by May 4, 1999. RMS, L.C. staffers on site numbered 13 on May 7, and rose to a peak 81 employees. Labor was provided by Albanian workers, who numbered 50 on May 7 and rose to 424 by June 1999. Security to the camp was provided by 140 U.S. Marines.[667] Leasing local machinery proved challenging due to the scarcity of modern equipment. RMS, L.C., subsequently contracted with a supplier in Turkey to provide machinery and equipment operators, who eventually numbered 68. The tents originally provided by the U.S. government developed torn seams, fabric sags, and leaks; higher grade commercial tents were used for the remainder of the installation.[668] On June 15, 1999, Camp Hope was completed and officially turned over to the Air Force. The camp had the capacity to accommodate 18,234 refugees. The first 490 refugees arrived on May 13, 1999. By May 18, the camp provided shelter to 1,858 refugees. By June 9, 3,466 refugees occupied the camp. Two additional camps each housing 20,000 refugees were under construction but were not completed before the end of hostilities on June 9, 1999. By the end of June, most refugees at Camp Hope had returned to Kosovo and camp operations ceased. On July 2, 1999, the JTF Shining Hope mission was declared complete and the camp was dismantled.[669]

Camp Hope near Fier, Albania, was built to house up to 20,000 Albanian Kosovar refugees in spring 1999 through AFCAP.

Among the last tasks completed under JTF Shining Hope through AFCAP was shipment of excess materiel from Durres, Albania to an Army warehouse in Germany.[670]

After the air strikes ceased and the combat was over, 7,000 U.S. service members served as part of the 48,000 member international peacekeeping mission Operation JOINT GUARDIAN headquartered at Pristina, Kosovo.[671] As part of that mission, EOD specialists remained in the U.S.-assigned sector of Kosovo to clean up and clear away the bombs that had been dropped and the mines left by retreating soldiers so that returning citizens were safe on their lands. EOD teams were especially pleased with the adaptability of the Air Force Research Laboratory's All-Purpose Remote Transport System.[672]

Expeditionary Aerospace Force (EAF)

The increasing tempo of Air Force missions and the continuous rotation of personnel overseas required a new method to structure deployments. On August 4, 1998, F. Whitten Peters, Acting Secretary of the Air Force, and Air Force Chief of Staff Gen. Michael E. Ryan announced a new plan to transform the Air Force into an Expeditionary Aerospace Force (EAF). Secretary Peters defined the concept to the Pentagon press, "recently we have also been experimenting with moving a large integrated force of fighter and bomber aircraft into a foreign theater as a unit with integrated command and control to give an area CINC the ability to put large, sustained firepower onto targets within 72 hours of an execute order. We have called these forces air expeditionary forces" (AEFs)."[673]

Operation VIGILANT WARRIOR was viewed by many as a catalyst for creating the EAF. In 1994, Saddam Hussein, President of Iraq, massed troops along the southern border of Iraq. This move induced fears of another invasion of Kuwait or of an attack on Saudi Arabia. As a result, U.S. forces quickly acted and transported 21,000 troops and 10,000 tons of supplies into the area within 10 days. Prepositioned resources from the Marine Corps and the Army expedited the operation. This operation prompted Lt. Gen. John P. Jumper, who served as the commander of USCENTAF and the Ninth Air Force, to reexamine Air Force capabilities and the potential to create an expeditionary force.[674] One year after Operation VIGILANT WARRIOR, the Air Force began working with the Navy in a rotational deployment as part of Operation SOUTHERN WATCH. These operations prompted General Jumper to create a prototype AEF and proposed a force of 36 aircraft for a 60-day deployment. Once his plan was approved by ACC, CSAF, and CENTCOM, it was put into motion. On October 28, 1995, AEF I was deployed to Shaikh Isa, Bahrain; the force was made up of 576 personnel and was deployed for 51 days. Seven additional AEFs were deployed between April 1996 and March 1998.[675]

The August 1998 announcement proposed the creation of 10 AEFs. In the past, deployments were determined by the selection of units for a specific operation or mission. The proposed EAF structure introduced a more integrated mechanism, with 10 AEFs that melded active, Air Force Reserve, and Air National Guard personnel from wings, groups and squadrons. The AEF relied increasingly on the Total Force concept. Ten percent of each AEF were ANG and Reserve troops.[676] Each AEF featured a range of weapon systems capabilities and each force was trained as one unit. One key advantage of the EAF plan was the potential to control the deployment tempo through advanced planning and scheduling. Each proposed AEF deployed for up to 90 days every 15 months. Defined deployment periods were a key aspect of the EAF concept, and addressed the greatest complaint among troops concerning frequent deployments with little advanced warning.

Deployments overseas also impacted personnel left to maintain CONUS air bases. The creation of AEFs addressed these concerns as well. Planners anticipated using ANG and Reserve personnel to backfill positions left open by deployed military personnel and contractors to fill less critical roles. The support force comprised 5,000 personnel slots to be distributed among bases. Secretary Peters stated, "we have wonderful Airmen who will do all that we ask them to do, but we have been asking them to do too much. Through the Expeditionary Aerospace Force initiative we hope to address these concerns and in the process achieve better retention rates among all of our people."[677]

As the EAF concept underwent revisions, the Air Force civil engineer role evolved. Of the potential 5,000 personnel slots available for home base support, civil engineering had the potential to capture 1,100 slots. According to Maj. Gen. Eugene A. Lupia, "AF CEs will play a significant role supporting AEFs, at home and abroad, solidifying the requirements for 28,401 active and reserve component engineers. Each AEF includes a full complement of Prime BEEF personnel, fire, explosive ordnance disposal and readiness capabilities while RED HORSE units will be available as on-call forces to each AEF."[678] Brig. Gen. Earnest O. Robbins II also commented on the benefits that EAF. He was particularly pleased that the EAF structure allowed personnel to schedule around deployments, "whether it be pursuing a degree, scheduling annual leave, or just having a much better handle on when they're likely to be called to go somewhere." General Robbins also praised the efforts made during EAF planning stages to address the workload of home bases during deployment, "we're providing some relief to the home-station workload as a consequence of all these deployments…when units like civil engineers, security forces, and communications deploy from home station there is a 'hole' left behind; there's a void left in the squadron back home that still has to support that base."[679]

On March 5, 1999, after multiple drafts, revisions, and reviews, the Air Force released the list of 17 "lead wings" for the 10 AEFs. In addition to the lead wings, two on-call wings were designated. The same month, the crisis in Kosovo overshadowed implementation of the plan. Those involved with the EAF initiative realized that the longer EAF was delayed, the more likely that it would be placed entirely on the backburner. Delays also increased the likelihood for further refinement of the plan. General Ryan continued the push to implement the EAF model. In May, he mandated the "stand up" date for the designated 10 AEFs as October 1, 1999. Along with General Ryan, others scrambled to illustrate how an EAF scenario could be applied in Kosovo. With the close of conflict in Kosovo in June, this priority lost momentum; however, General Ryan did not give up, and on October 1, 1999, implementation of the AEF concept began. By May 1, 2000, the first two AEFs under the new plan were deployed for Northern Watch.[680]

During his announcement on August 4, 1998, General Ryan described the concept of an expeditionary force,

> It's a systematic way to be able to present rapidly responsive forces that are light and lean tailored to the needs of the CINC. It's an integration of our total Air Force,

> something we haven't done in the past. Using our Guard and Reserve forces in a much more effective way than we have in the past. Using all of our capabilities across the spectrum in an effective way. It's institutionalizing in our force this expeditionary culture.[681]

What General Ryan and many others initially viewed as a hypothetical concept had become a reality. Despite future reorganizations and revisions, the Expeditionary Aerospace Force placed the Air Force in the 21st century. As predicted by Secretary Peters, the AEFs allowed the Air Force to be lighter and leaner, but also increased their air superiority.[682]

4th Air Expeditionary Force

Following the initial AEF deployments, the Air Combat Command recommended that AEFs be assigned a designation that credited their lead wing. As a result, earlier deployments were named AEF I thru AEF IV; the first AEF using the ACC recommended method was the 4th AEF with the 4th FW as the lead.[683]

The 4th AEF deployed to Qatar in February 1997. Ahead of the main deployment were 35 engineers from the 4th AEW Squadron that deployed in January and February. The first group, with seven engineers, specialized in electrical work and general utilities. They joined forces with the 823d RED HORSE Squadron to complete assignments noted during the earlier AEF III deployment to Qatar. Afterward, they began work on electrical grids and water lines. The second group of engineers arrived in February. This group included specialists in EOD, HVAC, and construction. They supplied force protection and also constructed facilities essential to house and support two-thirds of the entire deployment; this construction was completed in advance of the main deployment arrival.[684]

Under the leadership of Maj. Van Fuller, the 4th Air Expeditionary Wing (AEW) CES totaled 156 personnel by late February. They constructed and provided support for 147 tents, 51 shop buildings, and a variety of MWR facilities. During their deployment, they experienced record breaking rainfall. The civil engineers quickly installed manufactured floors in the tents to counteract the wet environment. The 4th AEF concluded their deployment in June. The unit's excellence was formally recognized when its members received all of the end-of-deployment awards for "outstanding performance," for the entire wing.[685]

Civic Action and Training MOOTW

Civic action and training programs were also examples of MOOTW. Deployments under these programs often achieved several objectives by combining training with nation building through the New Horizons program. The Air Force also continued its participation in the long-standing Civic Action Program to support economic development in Trust Territories of the Pacific Islands.

Under Total Force, ANG and Reserve personnel saw a dramatic rise in real world deployments as they participated in an increasing number of Air Force operations. Training for ANG and Reserve forces radically changed, incorporating more opportunities to train overseas while conducting humanitarian and nation building activities.[686] This training often occurred with active duty personnel, in a joint environment with members of other U.S. Armed Services, and sometimes with members of foreign military forces and civilian populations.

Civic Action Teams

Air Force civil engineers continued to serve on civic action teams sent to the Trust Territories of the Pacific Islands to assist in economic development in that region. In 1990, 13 volunteers were requested to serve an eight-month tour on Chuuk Island. The team members typically comprised one commander, one non-commissioned officer, three heavy equipment operators, two carpenters, one plumber, one engineering assistant, one interior electrician, two heavy equipment mechanics, and one independent medical technician. The tasks outlined for the teams included medium horizontal and small vertical construction projects. Four teams were scheduled through 1990 and two teams were selected in 1991. During the early 1990s, the teams were selected and assembled by AFESC. After the reorganization in 1991, the Air Force Military Personnel Center assembled the teams, which were deployed yearly throughout the decade.[687]

Deployments for Training

Deployments for training combined annual training required for active duty, Reserve, and ANG units with humanitarian assistance and nation building in foreign countries. These programs typically were joint efforts comprising personnel from several branches of the U.S. Armed Services combined with military counterparts in the host countries. The two programs described below were administered by major operational commands.

New Horizons or "Nuevos Horizontes"

The program called New Horizons or "Nuevos Horizontes" grew out of an initiative of Headquarters U.S. Southern Command (USSOUTHCOM) to support the nations in Central and South America. Begun in 1984 under Joint Task Force-Bravo, the program was called "Fuertes Caminos" and was organized and run by the U.S. Army as a combination civic action and military construction program.[688] The Air Force sent RED HORSE members to participate in the exercises as early as 1988.[689] In early 1990, AFESC personnel attended a deployment for training conference sponsored by USSOUTHCOM to discuss a strategy to support the militaries in Central American countries in nation building activities. Deployment for training activities combined both training for U.S. military personnel, but also transferred skills and technical capabilities to others through humanitarian and civic action projects in host countries. [690]

In March 1990, members of the 820th RED HORSE were assigned to work in Honduras establishing a landing strip and building two schools, five playgrounds and a community well. Eight members of the team were wounded during a guerrilla attack.[691]

After 1992, the Twelfth Air Force, which had assumed responsibility for the U.S. Air Forces in USSOUTHCOM in 1987, assigned all deployments for the Fuertes Caminos program, which was subsequently renamed New Horizons in 1996.[692] The program provided useful training deployments for active, Reserve and Air National Guard members. In 1995, members from the civil engineer squadrons from Columbus AFB, Mississippi, and Dyess AFB, Texas, deployed for Fuertes Caminos '95-El Salvador. Joining with members from the U.S. Army, Navy, and the Salvadoran Army, the purpose of the deployment was to build 10 schools, 2 bridges, and 15 water wells in local communities. The 36 members of the 14th CES from Columbus AFB, learned a lot about hands-on construction by having to mix their own concrete and place it into molds to form the walls.[693]

During 1996, approximately 250 Air Force reservists from Grissom ARB, Indiana; Carswell ARS, Texas; and, Niagara Falls ARS, New York, joined with soldiers and Marines in a joint task force to build schools and medical clinics in several locations in southwestern Honduras. The reservists worked in two-week rotations. Projects completed during the exercise included setting up and breaking down camp for the exercise participants; building schools, medical clinics, and a kitchen; grading a soccer field; installing latrines and running water; and, repairing equipment.[694]

During 1997, active duty and reserve Air Force civil engineers participated in New Horizons projects in Guyana, Haiti, Belize, El Salvador, Honduras, Panama, Brazil, and Chile. Of particular note was New Horizon Guyana 97, which was led by the Twelfth Air Force through Combined Task Force (CTF) Falcon. CTF Falcon comprised Air Force civil engineers, Marine Corps engineers, Army and Air Force medical personnel, U.S. and Guyanese security forces, and Guyanese Defense Force engineers for a total of 377 personnel; U.S. members of the CTF numbered 287. The cost of the project was over $7.2 million.[695] The 820th RED HORSE at Nellis AFB, Nevada, led the task force, organized and implemented the projects, and contributed 120 members to complete the exercise. CTF Falcon was tasked with setting up and breaking down a base camp and three outlying camps in remote areas, and constructing and renovating school buildings, medical clinics, and a retirement home. The exercise lasted from July 16 through September 13, 1997.[696]

The project New Horizons-Haiti 97 came about after the responsibility for continued operations in Haiti under Operation UPHOLD DEMOCRACY was transferred from the U.S. Atlantic Command to USSOUTHCOM. Force protection, administration and logistical support were transferred to the Twelfth Air Force as the lead agency. New Horizons-Haiti 97 was designed as a series of deployments for training activities that ultimately deployed 645 military personnel between June and December 1997. The Air Force sent Prime BEEF teams to complete construction projects and drill wells, and medical teams.[697]

New Horizons became an annual series of exercises that took place in several countries for a variety of purposes. Typically the program supported engineering, construction, and medical missions. Participants gained valuable training experience in austere conditions in remote areas, as well as training in project planning and logistics. In 1998, a 13-member team from the 820th RED HORSE squadron from Nellis AFB, Nevada, drilled water wells to provide fresh water to three remote communities in Peru as part of Nuevos Horizontes Disease Intervention 98. Pre-project planning involved Air Force civil engineers, as well as Army and Navy components. The Army provided the plans, the Air Force performed the drilling operations, and the Navy provided the drilling equipment and training to Air Force personnel on equipment use. The team included a project engineer, a project manager, an electrician, a utility craftsman, a mechanic, seven pavements and construction equipment personnel and a medical technician. The team was deployed between June 5 and July 5 and drilled four water wells.[698]

Members of the 820th RED HORSE Squadron, Nellis Air Force Base, Nevada, work on rebuilding the Malali District schoolhouse as part of New Horizons-Guyana 1997.

In 1999, the New Horizons program included projects in El Salvador, Guatemala, Nicaragua, the Dominican Republic, and Honduras. Many activities included recovery efforts from Hurricane Mitch in 1998. One important benefit from these New Horizons deployments was the successful deployments to conduct operations following Hurricane Mitch. In all, 20,000 active duty, Air National Guard, and Air Force Reserves personnel participated in the training exercises. In Nicaragua, a Prime BEEF team built a base camp on an abandoned Nicaraguan military base to support up to 400 persons. This required building tent floors, renovating and electrifying existing buildings, repairing the sewer system and erecting a hardback toilet facility. The Prime BEEF team worked in coordination with Marine Wing Support Squadron to lay out the camp. The base camp served as the home for incoming civil engineers, Army, and Marine teams who completed projects to assist the local residents.[699] In Honduras, Air Force civil engineers from March AFB, California, worked with Army and Air Force Guard and Reserve personnel to build a 480-personnel tent city to support later deployments, three schools and three medical facilities in local communities, and a new bridge.[700]

In Bolivia, the 819th RED HORSE squadron joined with a multi-service and multi-national team to drill the deepest water well ever drilled by the Air Force. This team drilled two solar-powered water wells; both wells were drilled to a depth of over 1,000 feet. This activity was one of many projects that occurred between May and September 1999. The team also improved drainage and erosion control on a stretch of dirt road by applying runway construction techniques, as well as constructing a bridge, laying concrete lanes for stream fords, and constructing a concrete school. The newly activated 819th used New Horizons deployments to validate its readiness posture.[701]

In 2000, contingents from the 307th RED HORSE squadron at Kelly AFB, Texas; Detachment 1, 307th RED HORSE from Barksdale AFB, LA; and the 820th RED HORSE, Nellis AFB, Nevada, deployed from January through March to Dangriga, Belize, as part of New Horizons. As members of a joint active/reserve team, the team's mission was to flush out wells and to repair hand pumps on five existing water wells and to drill four additional wells.[702]

The 823d RED HORSE squadron deployed as the lead unit for a CTF for New Horizons 2000 Jamaica. The mission comprised constructing two new buildings, drilling two new water wells, and providing two weeks of free medical care in local communities. RED HORSE set up the base camp and proceeded to work on constructing a school for underprivileged girls and a new concrete-block operations center containing 3,000 square feet for the Jamaica Defense Force. All participants were able to experience construction techniques using both hand tools and power tools. Part of the training was to work in an environment where not all equipment and materials was readily available.[703]

Cornerstone 2000

In 1995, the U.S. European Command began a deployment for training and humanitarian effort in the Balkans. In 2000, the focus of the Cornerstone program was Macedonia. More than 200 civil engineer personnel from the active duty, Air National Guard and Air Force Reserves joined with combat engineers from the Marine Reserve and active duty and reserve Navy Seabees. During a two month period, U.S. personnel worked with over 100 Macedonian soldiers and civilians to build two medical clinics, two schools, and a community center. One group lead by a Marine constructed a basketball court and playground using donated funds.[704]

Disaster Response

Air Force civil engineers also provided aid to support international and CONUS disaster recovery efforts. When hurricanes, typhoons, floods, and other disasters struck Air Force bases, civil engineers often were the first responders to help restore utilities, assess damage, and rebuild, both for their bases and their surrounding communities. Everywhere Air Force assistance was greatly appreciated.

International

In September 1996, Air Force civil engineers participated in a humanitarian effort to support the 12,000 residents of the island of Koror in the Republic of Palau. A bridge that connected Koror with another island, Babeldoab, collapsed and left the residents without potable water and electricity for a week. Pacific Command commenced Operation Pacific Bridge to alleviate conditions on the island of Koror. The U.S. Army Corps of Engineers assessed the bridge damage while the Navy acted as the Federal Disaster Control Officer. The Air Force supplied four reverse osmosis water purification units and three 60kW generators. Seven Air Force civil engineers accompanied the equipment to Koror to oversee the installation and operation of the units. In all, the equipment produced 323,000 gallons of potable water over a 90-day period until a permanent solution was implemented.[705]

Civil engineer personnel from Aviano AB provided relief to civilians of Assisi, Italy, after an earthquake in 1998 left 4,000 homeless. Civil engineers assisted Italian military and construction crews by clearing roads, grading camp sites, and connecting utilities to temporary units.[706] On June 27, 1998, an earthquake at Incirlik, Turkey, killed approximately 144 people and injured 15,000. Thirty personnel from Ramstein AB, Germany, volunteered to assess the damage at the air base. The team inspected every building for structural damage and inspected off-base housing for U.S. citizens.[707]

In October of 1998, Hurricane Mitch swept across El Salvador, Guatemala, Honduras, Nicaragua, and Belize killing more than 10,000 people and destroying thousands of houses. Because of the experiences gained from earlier New Horizons deployments, Air Force engineers were able to provide a high level of recovery assistance to the region. Soon following the hurricane, a 30-person joint service advance team with Col. Michael A. Aimone as senior Air Force engineer, deployed to the area to perform damage assessment and prepare for follow-on engineering teams. A combined RED HORSE unit comprising 400 personnel from the 819th RED HORSE Squadron and its Air National Guard component the 219th RED HORSE Flight, and the 820th RED HORSE Squadron deployed to provide needed assistance. The unit completed over 30 projects, mostly road and bridge repairs and construction. The RED HORSE unit also constructed a 275-foot long, 10-foot high sea wall to buffer the coasts in the future. In Colonel Aimone's words, "the amount of nation building the U.S. military provided during initial hurricane relief efforts in El Salvador, Nicaragua, and Guatemala has set a standard for the Air Force."[708]

CONUS and Overseas U.S. Air Force Air Bases

Hurricane Andrew

In August 1992, Hurricane Andrew caused tremendous damage to south Florida. With winds up to 175 miles per hour, the hurricane caused damages estimated at over $30 billion. Ninety percent of the buildings in the affected area were damaged; most of the damage occurred to roofing systems that allowed further damage to building interiors. Homestead AFB, Florida, was in the area of greatest impact. All buildings at the base were damaged. The roof of the chapel collapsed, crushing the side walls. Many buildings were left roofless. The winds had stripped metal siding off roofs and side elevations; metal framing members were twisted and collapsed.[709]

When Homestead AFB appeared to be directly in the path of Hurricane Andrew, 90 members from the 823d RED HORSE at Hurlburt Field, Florida, mobilized and convoyed to the area. The base CE squadron at Homestead AFB, which had survived the storm in a separate location, had already returned to begin the massive cleanup efforts. The RED HORSE team assisted in clearing debris, righting power poles and restringing power lines, and removing $200 million worth of equipment from ruined buildings. The team also constructed a 1,200-person tent city and eight, K-span structures. Each structure contained 5,000 square feet. The team repaired the roof on the commissary, rebuilt the Inter-American

Air Force Academy cafeteria, and assisted in repairing a local, off-base community hospital.[710] Prime BEEF teams from Seymour Johnson AFB, North Carolina; Barksdale AFB, Louisiana; and Bergstrom AFB, Texas, also assisted. These teams comprised carpenters, electricians, and heating, ventilation, and air conditioning specialists. A CEMIRT team from Tyndall AFB, Florida, also worked to stabilize the power production system.[711] On the conditions after the storm, Maj. Chuck Smiley, team chief of the RED HORSE team, reported to his headquarters, "Tell the guys who went up to Shaw (AFB, South Carolina), that compared to this, Hurricane Hugo was a thunderstorm."[712]

Typhoon Omar

On August 26, 1992, the eye of Typhoon Omar passed over Guam in the Pacific Ocean, causing damage to Andersen AFB, as well as the entire island. The 633d CES had prepared the base and its inhabitants over the years for this type of emergency, and emergency precautions were activated. The CES installed shutters on buildings, checked emergency power supplies, placed back-up generators in strategic locations, and moved equipment and vehicles indoors. The 633d also provided sand bags and plywood to secure facilities. When Typhoon Omar hit, the winds reached 160 miles per hour and over 16 inches of rain fell. During the storm the 633d CES manned the damage control center and informed the 633d ABW Crisis Action Team. Some civil engineers also remained at the water well pump and sewage lift stations to keep these systems going during the storm. Storm damage included loss of commercial electrical power; loss of the base water system; damage to operational building roofs, windows and doors; and, damage to 600 military family houses and some dormitories.[713]

The first step in base recovery was to deploy damage assessment teams. A typical base had four damage assessment teams, but to accomplish damage assessments for Andersen AFB's 1,700 industrial facilities and 1,734 family housing units in a timely fashion required a larger number of teams. CE established 60, two-person damage assessment teams to fill out pre-prepared spreadsheets. Team members did not need special training to fill in the blanks on the spread sheets and to determine the sizes of the holes in the buildings. The completed spreadsheets were turned into a 50-member cost estimating team.[714] In all, damages cost $54 million to repair. The recovery efforts were assisted by the base CE squadron, as well as Prime BEEF teams deployed from other areas in PACAF, including Hickam AFB, Hawaii; Yokota AB, Japan; and, Osan AB, ROK. In all, 800 Air Force civil engineer personnel assisted in helping Andersen AFB get back to business.

Tropical Storm Alberto 1994

In July 1994, Tropical Storm Alberto came ashore along the Gulf Coast of the United States. High winds and heavy rains caused damage at Eglin AFB and Hurlburt Field, Florida, and severe flooding at Robins AFB, Georgia. Robins AFB suffered several million dollars' worth of damage from severe flooding. The 653d CES at Robins AFB strove to protect critical utilities, such as power, airfield lighting, and the sewage treatment plant. Its members also stayed busy coordinating sand bagging efforts to protect critical facilities. Along with recovery efforts to the base, the 653d CES aided the local communities surrounding the base. Community efforts included repairing roads, delivering fresh water, and supporting local relief efforts.[715]

Great Plains Flood 1997

The 319th CES provided aid to the Grand Forks, North Dakota, citizens during the Great Plains flood in 1997. Personnel "supported sandbagging, water supply, housing, emergency shelter and restoration and recovery efforts" in 24-hour shifts. More than 3,000 civilians were evacuated to the base after the dikes broke. Potable water on the base quickly became an issue when the water tower on base neared empty. Water was trucked in from outside the flood area and reverse osmosis water purification units were delivered by the Army National Guard.[716]

Hurricane Seasons 1998-1999

Hurricane season of 1998 featured 10 hurricanes and four tropical storms, of which three hurricanes and four tropical storms came ashore.[717] Civil engineers along the coasts braced for the impacts on their installations and on the communities. Several units volunteered their support to locations in other states and countries. On August 23, 1998, Hurricane Charley struck Del Rio, Texas, and Laughlin AFB. The air base was without potable water or natural gas, and the flightline was covered in four feet of water. The base CES kept busy repairing buildings, purifying water, and restoring electricity. The 307th Reserve RED HORSE squadron from Kelly AFB arrived with a ROWPU and assisted the base CES.[718] CONUS installations affected during the 1998 and 1999 hurricane seasons included: Keesler AFB, Kelly AFB, Langley AFB, Pope AFB, and Seymour Johnson AFB.[719]

Pacific Typhoon Season 1998-1999

PACAF civil engineers faced similar challenges when coping with typhoons and flood damage. On August 8, 1998, the 554th RED HORSE Squadron from Osan, ROK, and 51st CES arrived at Army Camp Red Cloud to assist in flood damage control and cleanup. Civil engineers constructed levees and cleared roadways of mud. The civil engineers then supplied assistance to Camp Casey and Camp Hovey. In 11 days, the civil engineer teams "moved 60,000 yards of debris…and completed 13 major cleanup projects."[720]

On September 22, 1999 Typhoon Bart struck Kadena AFB, Japan, causing $5.7 million in damage. Damage Assessment and Repair Teams responded quickly and were able to return power to the main part of the base in under four hours. The majority of work was related to tree damage and flooding.[721]

SUMMARY

The 1990s was a decade of radical reorganization and restructuring for the Air Force and Air Force civil engineers; in many respects it established the tone and tempo for civil engineers to be the flexible and expeditionary force they would later become. The 1990s began with Air Force civil engineers achieving great success in supporting the Air Force mission during the Gulf War 1990-1991. Despite real world challenges in logistics and training, Air Force civil engineers accomplished an impressive amount of work to bed down troops during Desert Shield and to prepare for Desert Storm in the Persian Gulf region. Desert Shield/Desert Storm proved that the civil engineer community was well trained and ready for deployment. Serving with both joint and combined forces, Air Force civil engineers participated in an increasing number of international actions ranging from peace keeping to humanitarian. These included Somalia, Haiti, Bosnia, and Kosovo.

During the early 1990s, the Air Force civil engineers faced personnel cuts, both military and civilian, during the radical Air Force restructuring that affected all levels. Disaster preparedness and explosive ordnance disposal joined the civil engineer community, while Services was realigned to the MWR community. The reorganization trimmed personnel from both the Air Staff and AFCESA, but established AFCEE as a new FOA to direct and to support the burgeoning environmental program.

One component of the restructuring was the formation of the objective squadron at the base level. Civil engineer personnel became a multi-skilled force within broader career fields. With fewer military and civilian personnel to staff the base CE units, outsourcing and privatization initiatives became viable alternatives to operate and to maintain the peacetime bases. Base closures also were implemented to reduce the physical plant under Air Force control.

During the 1990s, the Air Force continued its aggressive pursuit of education and training programs. Lessons learned from Desert Shield/Desert Storm provided a review of the force's strengths and weaknesses, requiring an assessment of every aspect of troop preparation. The Air Force civil engineer was no exception to this postwar evaluation. Educational opportunities offered by AFIT, USAFA, and technical training schools were scrutinized to determine their adequacy. Assessments were completed by major commands, base civil engineers, faculty, and representatives throughout the civil engineer community. In addition, training programs were evaluated through the Readiness Training Review. Training activities, such as Readiness Challenges were further reviewed by readiness personnel. The essential goal of these reviews during the 1990s was to produce the ultimate Air Force civil engineer warrior—qualified to fulfill the needs of the civil engineer field and capable of surpassing expectations.

Maj. Gen. Eugene A. Lupia, The Civil Engineer, who retired in July 1999, expressed pride in the daily contribution civil engineers made to the Air Force, especially in deployments. He was proud to be told by senior Air Force leadership that "we don't want to go anyplace without our blue suit civil engineers, we don't want to be bed down by contractors,...we want our people to go with us when we go operational." General Lupia continued, "this is one reason why we have to keep telling people we can never give up our blue suit engineering capability-it's got to be organic to our operations."[722] Brig. Gen. Earnest O. Robbins II, the succeeding Civil Engineer, was proud to take the reins of the Air Force civil engineer organization and to continue to support Air Force missions throughout the world. The civil engineer organization was, in his words, "relevant, right-sized, and ready" for transformation in the new millennium.[723]

CHAPTER 6

MEETING THE NEW CENTURY
2001-2012

INTRODUCTION

The threat of international terrorism became a stark reality as the United States experienced the brutal and well-orchestrated suicide attack by Al Qaeda on September 11, 2001. At 8:46 a.m., Al Qaeda operatives flew hijacked American Airlines Flight 11 into the north tower of the World Trade Center on the southern tip of Manhattan, New York City, New York.[1] A second hijacked aircraft, United Airlines Flight 175, struck the south tower at 9:03 a.m. At 9:37 a.m., a third hijacked aircraft, American Airlines Flight 77, struck the Pentagon near Washington, D.C. A fourth plane crashed into a field in rural Pennsylvania at 10:03 a.m. after passengers and flight crew attempted to gain control of the hijacked commercial flight.

The attack resulted in an unprecedented number of civilian causalities and prompted both a military response and revised policies for domestic security. As eloquently summarized by Maj. Gen. L. Dean Fox, The Civil Engineer between 2003 and 2006, these events "ripped a hole in our nation and its sense of security."[2] After September 11, 2001, the U.S. military establishment focused on transformation to meet new challenges in a dynamic global environment.

The Pentagon attack particularly resonated with the Office of The Civil Engineer, which had moved from the D-Ring offices of the Pentagon to Crystal City during the 1997 renovation. The former offices were damaged directly during the attack.[3] The relocated offices of The Civil Engineer in Crystal City provided a reconstitution point for the leadership of the Deputy Chief of Staff for Installations and Logistics team in the aftermath of the attack.

The U.S. response to the terrorist attack was swift and direct. The security of the country was safeguarded immediately through Operation Noble Eagle (ONE). Those responsible for the attack were sought through the initiation of a new kind of war, the Global War on Terrorism (GWOT), renamed Overseas Contingency Operations by 2011. Early military planning focused on Afghanistan, where Osama Bin Laden, the leader of Al Qaeda, lived and operated training bases for operatives with full knowledge of the Taliban government. Within weeks of the September 11, 2001 attacks, the United States formed an international coalition drawn from the United Nations (UN), NATO, and others, to support the fight against terrorism. Within a month, U.S. military leaders developed a plan for military operations and Operation Enduring Freedom (OEF), the code name for the war in Afghanistan, began on October 7, 2001.[4] After the initial push, military action in Afghanistan waned for a few years as military operations in Iraq rose in prominence. A surge to stabilize Afghanistan occurred near the end of the decade and continued through 2011.

By 2002, President George W. Bush and his administration were constructing a case for military action against dictator Saddam Hussein in Iraq. Since the end of the Gulf War in 1991, the United States had supported a policy of containment in Iraq. UN inspectors had been denied access to Iraq to check for weapons of mass destruction for several years prior to September 11, 2001. In early 2002, President George W. Bush characterized Iraq as one member of the "axis of evil." Senior advisors to the President linked Saddam Hussein to Al Qaeda and cited evidence that Hussein had developed and stockpiled weapons of mass destruction. Citing the threat of terrorism and the actions of Iraq as justification, the Bush Administration developed a policy of pre-emptive action as opposed to containment and deterrence. This defense strategy was articulated in *The National Security Strategy of the United States of America* dated September 2002. The United States sought to justify military action against Iraq through a UN resolution, but did not receive UN support. In March 2003, the United States, supported by Great Britain, initiated a military action against Iraq, known as Operation Iraqi Freedom

(OIF). The initial fighting was quickly over and the United States became involved in an insurgency and nation rebuilding program that ended in December 2011.[5]

The new geo-political realities that shaped the operations of the Department of Defense (DoD) and the U.S. Armed Services in the twenty-first century were outlined in the Quadrennial Defense Review (QDR) published on September 30, 2001. The QDR established the basis for many of the initiatives and changes that occurred throughout the decade and affected every level of the military organization, including Air Force civil engineers. While the QDR was drafted mostly prior to the events of September 11, 2001, the attacks served to highlight the need to transform DoD and the U.S. Armed Services. The term "transformation" became the watch word of the decade. The revised U.S. military strategy recognized that attacks upon the United States and its allies were possible from any direction, in a variety of ways, and using a variety of weapons, including chemical, biological, and nuclear arms. To meet these threats, the U.S. military must be capable of defeating attacks simultaneously in two theaters of operation and to decisively win in one of the theaters of operations. The strategy held that U.S. forces would fight from forward bases with immediately deployable personnel, including aircraft strike capabilities from within and beyond the theater of operations. The U.S. military also needed to participate in small-scale contingencies with allies and friends.[6]

The Secretary of Defense outlined four key goals for the U.S. Armed Services in the 2001 QDR:

- Assuring allies and friends of the United States steadiness of purpose and its capability to fulfill its security commitments;
- Dissuading adversaries from undertaking programs or operations that could threaten United States interests or those of our allies and friends;
- Deterring aggression and coercion by deploying forward the capacity to swiftly defeat attacks and impose severe penalties for aggression on an adversary's military capability and supporting infrastructure; and,
- Decisively defeating any adversary if deterrence fails.[7]

Key strategies were developed to support the new goals. Among these strategies were managing risk, shifting military response to a capabilities-based approach, developing a broad portfolio of military capabilities, and transforming defense. Transformation was a critical component, positioning DoD and the U.S. Armed Services for efficient operation in the new decade. The transformation process was envisioned as a multi-year endeavor. As stated in the 2001 QDR,

> Transformation is at the heart of this new strategic approach. The Department's [of Defense] leadership recognizes that continuing 'business as usual' within the Department is not a viable option given the new strategic era and the internal and external challenges facing the United States military. Without change, the current defense program will only become more expensive to maintain over time, and it will forfeit many of the opportunities available to the United States today. Without transformation, the United States military will not be prepared to meet emerging challenges.[8]

Transformation was initiated incrementally from minor changes, then expanded to comprehensive programs comprising the entire U.S. military. A first step was the establishment of the Transformation Office within DoD. Transformation was based on four pillars:

- Strengthening joint operations through standing joint task force headquarters, improved joint command and control, joint training, and an expanded joint forces presence policy;
- Experimenting with new approaches to warfare, operational concepts

and capabilities, and organization constructs such as standing joint forces…;
- Exploiting United States intelligence advantages…;
- Developing transformational capabilities through increased and wide-ranging science and technology, selective increased in procurement and innovations in DoD processes.[9]

The 2006 QDR continued the emphasis on transformation begun in 2001. The 2006 QDR defined two fundamental imperatives for DoD:

- Continuing to reorient the Department's capabilities and forces to be more agile in this time of war, to prepare for wider asymmetric challenges and to hedge against uncertainty over the next 20 years.
- Implementing enterprise-wide changes to ensure that organizational structures, processes and procedures effectively support its strategic direction.[10]

DoD's four priorities were: defeating terrorist networks, defending the homeland in depth, shaping the choices of countries at strategic crossroads, and preventing hostile states and non-state actors from acquiring weapons of mass destruction (WMD).[11] A new Air Force mission statement was adopted following discussions and deliberations: "Deliver sovereign options for the defense of the United States of America and its global interests…to fly and fight in Air, Space and Cyberspace."[12]

Efforts to transform the military organization were wide ranging and varied. Measures included organizational restructuring, adopting contemporary business practices to streamline work processes to increase efficiencies, reducing staffing through the Force Shaping initiative, building new combat capabilities, ensuring flexible and agile combat support, integrating into the joint Service environment, adopting an asset management approach, applying innovative approaches to managing Air Force real property assets, adopting lean management techniques, and managing the organization as an enterprise. Some initiatives for transformation were mandated from the Office of the Secretary of Defense (OSD) or the Air Staff, while other initiatives were developed from within the ranks. In February 2006, the Secretary of the Air Force created a new program of continuous process improvement known as "Air Force Smart Operations 21" (AFSO21). This program combined elements of several business management models including Lean management, Six Sigma, and Theory of Constraints. The primary goal of AFSO21 was to eliminate waste – waste of time, manpower, and money. Processes were analyzed to examine methodologies that added value to the work and those did not, and to identify ways to reduce redundancies and waste.[13] *The Air Force Smart Operations for the 21st Century CONOPS and Implementation Plan* was drafted in February 2006 and issued as a *Playbook* in May 2008.[14] The AFSO21 Process Council was chartered in June 2006.[15]

Gen. John P. Jumper, Air Force Chief of Staff between September 2001 and September 2005, led the charge for transformation for the Air Force early in the decade. As it had in the past, the Office of The Civil Engineer shaped the effects of transformation for the civil engineering organization. As Maj. Gen. L. Dean Fox wrote,

> The Air Force defines transformation as "a continuous process by which the Air Force achieves and maintains advantage through changes in operation concepts, organizations, and/or technologies that significantly improve its warfighting capabilities or ability to meet the demands of a changing security environment."…we as engineers are in the midst of our own dynamic transformation, from the organization of MAJCOM CE staffs, to the way we conduct our comprehensive planning, identify requirements, and program, prioritize and execute our programs.[16]

During the mid-years of the decade, the Air Force goals were fighting and winning the GWOT; developing and caring for Airmen and their families; and, recapitalizing and modernizing the aging Air Force weapons systems.[17] In 2009, a new set of Air Force strategic priorities was released. The new priorities were "reinvigorate the Air Force nuclear enterprise; partner with the joint and coalition teams to win today's fight; develop and care for Airmen and their families; modernize our air and space inventories, organizations and training; and, recapture acquisition excellence."[18]

Air Force civil engineers contributed to all aspects of military activities throughout the decade. Air Force civil engineers were among the first responders at ground zero on September 11, 2001. They supported bases from which combat air patrols were launched during ONE. By the end of October 2001, Air Force civil engineers were on the ground in the countries surrounding Afghanistan to bed down troops involved in OEF and deployed into Afghanistan itself to build forward bases. Air Force civil engineers also were in place early in Southwest Asia (SWA) building and maintaining forward bases needed to support OIF. During the early phases of combat, more than 4,500 Air Force civil engineers deployed to the area of responsibility (AOR). They expanded 10 existing bases and established 12 new bases to accommodate troops and aircraft needed for the fight.[19] Air Force civil engineers continued to support these long-term military commitments throughout the decade. They also served in new roles in combat situations as airborne RED HORSE, supporting Army personnel as "in lieu of" forces, and as expeditionary Prime BEEF units. Air Force civil engineers also were active in rebuilding missions and served worldwide on Joint Engineer Teams, Civil Affairs Teams, Provincial Reconstruction Teams, and Field Engineer Teams.[20] Air Force civil engineers served as advisors and instructors in setting up new emergency services and military units in Afghanistan and Iraq. No longer were Air Force civil engineers necessarily deployed with their units to erect tent cities to support Airmen and aircraft; by 2010, 53 percent of deployed Air Force civil engineers were tasked to joint expeditionary forces.[21]

In 1999-2000, the Air Force civil engineer community comprised 64,000 active duty and Air Reserve Component (ARC) personnel. The ARC included the Air National Guard (ANG) and Air Force Reserves. Air Force civil engineers managed a budget of more than \$5.6 billion per year to operate and maintain facilities and infrastructure.[22] The number of installations worldwide was 168.[23] In 2004, 59,700 civil engineers served service-wide; by 2005, the number had decreased to 58,442.[24] By 2010, the number of civil engineers remained at nearly 60,000. The Air Force real property portfolio contained 160,000 assets comprising buildings, structures, and linear structures, on nearly 10 million acres with a total value of over \$263 billion. These assets were located on 78 major bases and 121 ARC installations.[25]

The Air Force civil engineering community participated fully in the transformation initiatives designed to realize a leaner, more agile, and flexible organization responsive to the challenges encountered during deployment, as well as those faced in the management of home bases. Air Force civil engineers adopted the changes directed by DoD and the Secretary of the Air Force and expanded upon Air Force direction to generate numerous transformation initiatives for the civil engineering community. Smart business practices applied to civil engineering management for greater efficiencies and cost savings were integral to civil engineer transformation.

CIVIL ENGINEERING STAFF PROGRAMS AND POLICIES

The Civil Engineers

Maj. Gen. Earnest O. Robbins II served as The Civil Engineer from July 23, 1999 to May 16, 2003. He came to the position after serving as Command Civil Engineer at Air Force Space Command (1993-96) and at Air Combat Command (1996-99). This was his third assignment at the Pentagon. He had served as an action officer in the Programs Division and as the executive officer in the Directorate of Engineering and Services during the first half of the 1980s. General Robbins' goals when he became The Civil Engineer were to support the Air Force leadership and to ensure that the civil engineering community was "relevant, right-sized and ready."[26] In 1999-2000, Air Force civil engineers were supporting long-term missions in Bosnia and Kosovo and Operations NORTHERN WATCH and SOUTHERN WATCH over Iraq. At home, financial resources for civil engineer budgets remained tight. In 2000, General Robbins requested a $1.65 billion military construction budget to sustain and operate existing facilities, to bed down new missions, to uphold the quality of life, to optimize use of public and private resources, to reduce infrastructure, and to continue environmental leadership.[27] In FY01, the U.S. Congress awarded the Air Force an additional $5.15 million for a total Military Construction (MILCON) budget of $1.2 billion. General Robbins argued for additional operations and maintenance funds for the restoration and modernization of aging base facilities nearing their commercial recapitalization benchmark of 50 years.[28] For the FY03 budget cycle, the share of MILCON and operations and maintenance funding for facilities sustainment, restoration and modernization (S/R&M) reached adequate levels for the first time in a decade.[29]

General Robbins also oversaw the initial implementation of the Aerospace Expeditionary Forces (AEF) under which rotational deployments of combat, combat support personnel, and equipment to support long-term Air Force operations were instituted. He worked to implement the core competencies identified in the Air Force civil engineer strategic plan: expeditionary engineering, emergency services, installation engineering, housing excellence, and environmental leadership.[30] General Robbins also continued to coordinate closely with his counterparts in other U.S. Armed Services.[31] He particularly worked with the construction contracting agents the U.S. Army Corps of Engineers and the Naval Facilities Engineering Command to improve the acquisition process for facilities and construction services.[32]

General Robbins was The Civil Engineer during the attack of September 11, 2001 and the beginnings of OEF and OIF. Writing shortly after the tragedy, General Robbins expressed pride in the professionalism of Air Force civil engineers,

> members of the civil engineer team continue to support our Air Force. Despite our grief and our concerns for our country and our fellow citizens, we continue to do whatever it takes to keep our installations safe and secure, while taking care of the important day-to-day functions which keep our installations going….I am reminded of the strong bonds of the Air Force civil engineer family and the contributions and sacrifices of all the men and women who proudly serve our nation. We will get through this together.[33]

While singling out the exceptional service of the Air Force fire protection specialists, General Robbins concluded by praising every military and civilian man and woman in the Air Force civil engineering organization for their contributions.[34]

Upon his retirement in May 2003, General Robbins described his four-year tenure as The Civil Engineer as extraordinary. He wrote,

> Despite incredible stresses on the personal and professional lives of our people as we've spread our "footprint" across the globe, we've continued with the same dedication, perseverance and can-do attitude that I first saw way back in 1969 [when he joined the Air Force]. My pride in our career field is based not on the breadth and depth of the programs we run or on the size of the budgets we manage, but on the quality of the products and services we deliver and, most importantly, on the talent and enthusiasm of those within our Civil Engineering family.[35]

General Robbins was credited with challenging Air Force civil engineer perceptions related to the essential role played by civil engineers; energizing facility investment programs; making substantial improvements to civil engineering readiness capabilities, especially in the nuclear/ biological/chemical

Maj. Gen. L. Dean Fox

defense programs; developing exceptional rapport with Congress to gain their confidence in Air Force initiatives; and strengthening CE training across the board.[36]

Maj. Gen. L. Dean Fox served as The Civil Engineer from May 16, 2003 to June 23, 2006. He came to the position from Headquarters AMC, where he was the Director of Civil Engineering, and was the second U.S. Air Force Academy (USAFA) graduate to hold the office.[37] At the time he assumed office, Air Force civil engineers were supporting ONE, OEF, and OIF. He oversaw the largest Air Force budgets in over a decade, administering $1.64 billion in MILCON funding for continental U.S. (CONUS) projects to cover new mission beddowns, current mission needs, quality-of-life improvements, and environmental compliance. In addition, S/R&M funds also increased.[38]

General Fox stressed the role of the Office of The Civil Engineer in establishing policy, advocating for personnel and financial resources, and supporting civil engineers on the base level in executing their mission. "I know that missions are critical, but there are no missions without people. People are the root of all success. We talk about quality of life and people programs. I talk about mission and people. In my view, everything is people first," General Fox stated. [39]

General Fox launched the initiative "Back to Bases." He reflected on his priorities, "My perspective, from the eight years that I have spent as a major command civil engineer, is slanted toward taking care of people at the base level, so they can take care of the mission. Our missions are flown from bases. The preponderance of our people work at, or are attached to, our bases, so we need to focus on that base-level mission and people."[40] He also continually stressed safety on the job, at home, and during recreation. "Safe work environments and habits are vital to our continued productivity and success at home and while deployed," General Fox wrote.[41]

In addition to ongoing civil engineer participation in overseas deployments and maintaining the CONUS bases, General Fox also implemented the initial steps of Air Force transformation initiatives.[42] The Air Staff was reorganized into an A-Staff structure in February 2006, and the Office of The Civil Engineer became AF/A7C. General Fox oversaw a round of base realignments and closures (BRAC) in 2005 and the preparation of a QDR in 2005-2006. Natural disasters also posed challenges during

Maj Gen. Del Eulberg

the period as several Air Force bases were severely damaged during the active hurricane seasons of 2004 and 2005.[43]

On his retirement in 2006, the *Air Force Civil Engineer* paid General Fox the following tribute,

> During Maj. Gen. Fox's tenure as The Air Force Civil Engineer, there was an exponential increase in the requirement for Air Force civil engineers for contingency operations, in support of Operations Enduring Freedom and Iraqi Freedom. His leadership during this demanding time has been both dynamic and concerned, with mission needs and warfighter needs always at the forefront. At the same time, his commitment to quality for the Air Force's bases, its Airmen and their families around the world created the largest housing program in Air Force history, one of the largest military construction programs in the last 15 years, an award-winning energy program, and an extraordinary stewardship of the environment.[44]

The annual award for the year's most outstanding senior military manager was named for General Fox in honor of his service.

Maj. Gen. Del Eulberg became The Civil Engineer, Deputy Chief of Staff, Logistics, Installations, and Mission Support, on June 23, 2006 and served until June 5, 2009. General Eulberg was also a USAFA graduate and came to the position after serving as Director, Installations and Mission Support at AMC.[45] At Headquarters AMC, he instituted many reforms in the civil engineer organization of that major command. At the Air Staff level, he continued to guide and to implement the reforms begun under his predecessor. He furthered the imperative for transformation of the civil engineer enterprise by supporting review and revision of civil engineering business practices to foster positive change in the civil engineering culture. Under General Eulberg, Air Force civil engineer deployments to SWA continued in support of OEF and OIF; more than 2,900 Air Force civil engineers served on assignments during 2009.[46] An increasing number of Air Force civil engineers filled "in lieu of" positions, taking on assignments supporting the U.S. Army in direct combat units. At home, the Air Force instituted personnel cuts to reallocate money to modernize weapons systems.

General Eulberg summarized the conditions when assuming The Civil Engineer position,

> The challenges that we face today come from many directions. We are a nation at war, facing a new enemy, in a resource-constrained environment. We have to reduce the size of the Air Force by 40,000 personnel to help the Air Force modernize our weapons systems to stay relevant for the future. Civil Engineering is a cornerstone on the combat support team, and we have to do our part in meeting these demands through transformation.[47]

General Eulberg defined the highest civil engineer priority as maintaining warfighting capability and winning the GWOT. These priorities demanded that Air Force civil engineer personnel be "organized, trained, and equipped to support the joint warfighter."[48] He instituted a stringent lessons learned component into all training programs and transformation processes.[49] A second challenge facing the civil engineer community was operating and maintaining the Air Force installations around the world.

General Eulberg forcefully supported Air Force transformation goals and implemented the *Civil Engineer Transformation Plan*.[50] He vigorously supported reexamining and reanalyzing the civil engineering business processes. He wrote,

> We cannot ask our people to "do more with less." It is incumbent upon our leaders at every level to come up with ways to do their jobs more effectively and efficiently. We must remain focused on those requirements that directly impact mission capability, and stop performing those functions that do not. We must also pursue greater reliance and interaction between the Services as we jointly go forward, and re-look at how we leverage the capabilities of the private sector as well.[51]

General Eulberg introduced business concepts and practices into the civil engineering organizational structure to improve efficiencies. He instituted the asset management approach, the modernization of information technology, energy savings, centralization of key processes, risk-management assessments, strategic planning, and activity management plans. The civil engineer transformation vision was captured in the phrase "20/20 by 2020."[52] This slogan succinctly summarized an overall goal for Civil Engineering. Funding available for installation support had been reduced 20 percent since FY06, so civil engineers sought to reduce the Air Force physical plant on which it spent money by 20 percent by the year 2020. Since the 2005 BRAC recommendations did not impose a major reduction in the total number of Air Force bases, General Eulberg proposed to "shrink the bases from within." This goal helped fund the Air Force goal of recapitalizing and modernizing its weapons systems.

General Eulberg reflected on his accomplishments upon his retirement,

> I have never been as proud of the Civil Engineering career field as I am today, and I salute each and every one of you for your continued dedication to the mission, and commitment to our ongoing journey to transform Air Force installation management. Our community is experiencing the highest operations tempo I have seen during my 30+ year career because our skills and expertise continue to be in high demand, particularly within the joint team…. As you are well aware, we have had to transform the way we do business to lessen the burden on our Airmen and to ensure that we can continue to bring operational support to the fight. Although it is a lot of work up front, I assure you that over time you will reap the benefits of the new tools and processes


Maj Gen. Timothy A. Byers

> that are continuing to be developed…. We have strengthened our organization and continue on our quest to keep our people informed and provide the field with helpful tools to manage our installations as effectively as possible.[53]

When General Eulberg retired, the annual award for the year's outstanding Asset Management Flight was named in his honor.

Maj. Gen. Timothy A. Byers became The Civil Engineer on June 5, 2009 and occupied the office as of October 2012. General Byers was previously the Director of Installations and Mission Support, Headquarters, Air Combat Command (ACC), Langley AFB, Virginia. General Byers adopted the phrase "Build to Last…Lead the Change" to characterize his philosophy as The Civil Engineer. He was committed to continuing his predecessors' transformational change throughout the civil engineering community and wrote,

> As engineers, our fundamental intent is to build something of quality, something that lasts, whether we're talking about facilities or infrastructure or services we provide. What we do should last through all kinds of changes - budgetary, environmental, or energy, to name just a few. Our installations should grow and change with the needs of the Air Force, our mission, our Airmen, and our communities. Even our Civil Engineering enterprise should be able to adjust and change when our strategic priorities, our deployments, our budgets change. It's part of our transformation.[54]

General Byers identified the following challenges to the civil engineering community as he began his service. One was "to capture all the lessons learned, transformation changes, and improvements that we've made in Civil Engineering so we build ready engineers, build great leaders, and build sustainable installations." Another challenge was to balance superb support to overseas contingency operations and increased requests for Air Force civil engineer services associated with high operations tempo, personnel stress and decreasing retention rates. An additional challenge was to maintain high quality education and training so that deployed Airmen were prepared to meet combat situations. "We need to be more personally engaged with our people to ensure that we're doing the right things to develop them. We have to make sure we have motivated engineers who want to lead at all levels. We need to build great leaders," General Byers said. "Build Ready Engineers, Build Great Leaders, and Build Sustainable Installations" became the three goals that General Byers used throughout his time as The Civil Engineer to not only guide his work but also as a communications strategy so everyone could understand and work his three priorities. General Byers effectively used social media (Facebook and Twitter) and a CE Portal to communicate with the entire career field and to provide tools such as Commander's Call Talking Points and the latest version of topical Playbooks. He also instituted a monthly CEnterline Video message available on the CE Portal where he or one of his staff could speak directly on a particular topic of interest.[55]

Building and maintaining sustainable installations was yet another challenge identified by General Byers. He was committed to continuing the transformational change to standardize civil engineering business processes begun under his predecessors and to implement the vision of 20/20 by 2020. He further was committed to fielding the technologies of the next generation of information technologies (NexGen IT) and for EOD, fire protection, and Emergency Management. "We need to focus on everything from our energy initiatives to environmental sustainability from construction, operations, and maintenance to the divesting of all our facilities and infrastructure" General Byers wrote.[56] "We will have to stop doing some things because is it not about 'doing more with less,' but rather 'doing less with less.'"[57] He initiated a review of all capabilities and processes from the base, major command, field operating agency (FOA), and Air Staff levels. "We had to ensure we provide the core civil engineer capabilities to fly, fight and win across the full spectrum of operations in air, space and cyber domains." General Byers challenged the teams to not only identify, but to prioritize core capabilities and streamline "to be" processes to do things "smarter, faster, better and cheaper." He implemented the first Air Force-wide priorities for S/R&M projects using standard asset management principles and key performance indicators. He also established the first Installation Governance structure to oversee Air Force-wide civil engineering priorities, Program Objective Memoranda, budget and execution of facility, infrastructure, environmental and housing programs.

Department of Defense and Air Force Transformation

Transformation of the U.S. military culture, including all levels of the Air Force, was the major theme of the first decade of the twenty-first century. Transformation initiatives were incorporated into funding vehicles, personnel allocations, and the reorganization of administrative structures. DoD emphasized agility, flexibility, and innovation in transforming the military support structure. It proposed review of all processes to define core and non-core functions, to jettison non-core functions, and to focus only on those areas contributing directly to warfighting. DoD also proposed transformation of business processes and infrastructure "to both enhance the capabilities and creativity of its employees and free up resources to support warfighting and the transformation of military capabilities."[58]

In response to directives on transformation issued by DoD, the Air Force introduced the continuous process improvement approach to revitalize and transform the entire Air Force culture. Integrated process teams were formed to evaluate all processes within the organization. Air Force Smart Operations for the Twenty-First Century (AFSO21) provided the tools to survey and evaluate processes and implement changes throughout the organization. Areas selected for transformation included manpower reductions, more efficient operations, and modernizing weapons systems.[59]

The 2001 QDR outlined a reorientation of the global posture of the U.S. military. The Air Force was directed to develop plans to establish forward bases in areas beyond the range of existing overseas bases in Europe and northwest Asia. A need was identified for additional operating bases in the

Pacific, the Indian Ocean, and Middle East regions. Operating bases in Western Europe and northeast Asia were maintained to serve as hubs for power projection in support of contingencies in other parts of the world.[60] The 2001 QDR also emphasized the need to recapitalize weapons systems and aging facilities.[61]

Another initiative contained in the 2001 QDR was a fifth round of base realignment and closure (BRAC) recommendations to reduce excess military facilities by 20 percent.[62] The Secretary of Defense proposed the immediate implementation of BRAC; members of the U.S. Congress voted in 2001 to postpone BRAC until 2005.

The Secretary of the Air Force also supported adopting efficient business practices throughout the Air Force. The concept of "lean management" was applied to Air Force processes and procedures. Lean management was a private-sector business technique originating in the automotive industry to streamline production by identifying "value-added work in processes" and eliminating waste.[63] On November 7, 2005, the Secretary of the Air Force and the Air Force Chief of Staff issued a memo directing the Air Force to adopt lean management strategies in 2006 as part of the AFSO21 initiatives.[64]

Civil Engineer Transformation

Air Force civil engineers embraced transformation and applied it to all aspects of the civil engineer organization. Transformation was defined as "exploring every aspect of how CE does business, including its approach, methods, and tools, and incorporating changes where needed."[65] Promising areas for civil engineer transformation included manpower reductions, efficiencies from re-engineering civil engineer processes, upgrading information technology, and modernizing facilities and infrastructure.[66] Transformation initiatives for civil engineers were proposed from all levels of the organization, from Air Staff, major commands, and bases. One of the first areas where transformation began was in the structure of the civil engineer organization.

<u>Major Command and Air Staff Reorganizations</u>

Air Mobility Command (AMC) was tasked with airlift capability and with increasing the Air Force global posture as directed under QDR 2001. AMC embraced transformation early in the decade. The AMC Commander Gen. John W. Handy began to reorganize the major command in February 2002 to streamline operations. Two numbered air forces were merged into one, the Eighteenth Air Force, to streamline the chain of command for AMC's 12 wings.[67] Base-level support provided by the Mission Support Group was refined.[68]

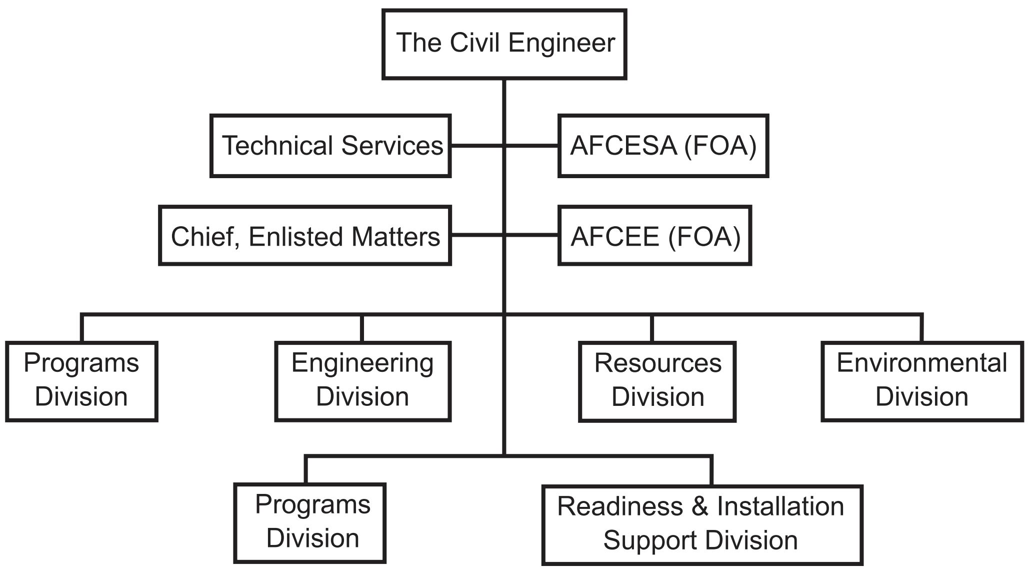
AMC Headquarters staff was reorganized to reflect wartime operations. AMC Civil Engineer Brig. Gen. Del Eulberg proposed a new major command civil engineer organizational structure in July 2003. As General Eulberg explained, "Reorganizing on 'day one of the war' is not the best way to prepare for future conflicts…especially when we face a small, highly mobile enemy—global terrorists. We need to streamline our headquarters functions so we can quickly adapt and provide maximum support to the joint warfighter."[69] On October 1, 2003, AMC adopted the A-Staff structure and established the A7—Directorate of Installations & Mission Support. The adoption of the A-Staff organization at the CONUS AMC major command paralleled the A-Staff organization of combatant commands in the field. The purpose of the AMC major command civil engineer reorganization was "to create a directorate that integrated combat support—not just 'contained' traditional combat support functions. This integration is an essential element in streamlining combat support at the headquarters level, just like we have done on the operational side," said General Eulberg.[70] At AMC, this reorganization fully integrated Civil Engineering and Services so that one commander led all combat support functions.[71] The A7 Directorate incorporated a new division, Mission Support Integration, to serve as a single point of contact for Expeditionary Combat Support issues. Other divisions within the directorate included

Readiness Operations, Plans and Programs, Resources, Environmental, Construction, Civil Engineer Operations, and Housing.[72]

By spring 2003, the A-Staff organizational structure had been adopted by the Air Force Space Command (AFSPC) staff at Peterson AFB, Colorado. The new A7 - Mission Support Directorate included six divisions: programs, environmental, housing, operations, resources, and emergency services/expeditionary engineering. The A7 organization eliminated the deputy civil engineer and a separate engineering division. The tasks related to planning, programming, and construction were consolidated into the Programs Division.[73]

In 2004, the Office of The Civil Engineer (AF/ILE) in the Air Staff at the Pentagon comprised the following divisions: Engineering (AF/ILEC), Technical Services (AF/ILEE), Housing (AF/ILEH), Resources (AF/ILER), Programs (AF/ILEP), Environmental (AF/ILEV), and Readiness and

Figure 6.1 The Office of The Civil Engineer Organizational Chart, 2004



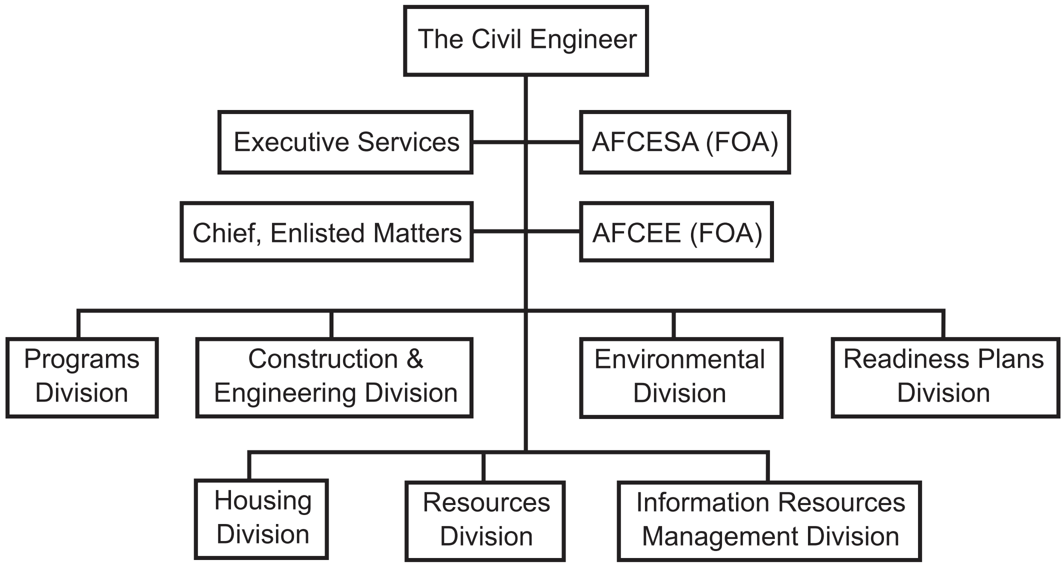
Source: AF/A7C Organizational Chart, October 25, 2004, AFCEC History Office.

Installation Support (AF/ILEX). Two field operating agencies (FOAs), the Air Force Civil Engineering Support Agency (AFCESA) and Air Force Center for Environmental Excellence (AFCEE), reported directly to The Civil Engineer (Figure 6.1).[74]

On February 1, 2006, the Air Staff at the Pentagon adopted the "A-Staff" organizational structure similar to the organizational structure of the Army's G-Staff, the Navy's N-Staff, and the Joint Chiefs of Staff's J-Staff. The reorganization facilitated internal communications within the Air Staff and among other U.S. Armed Services.[75] Under the A-Staff organizational structure, the Office of The Civil Engineer was slotted under A4/7—Logistics, Installations and Mission Support. The Office of The Civil Engineer was organized into the following divisions: Housing, Information Resources Management, Programs, Construction & Engineering, Resources, Environmental, and Readiness Plans. (Figure 6.2)[76] The A-Staff organizational structure was implemented at all major commands by May 1, 2006.[77] The title of the Civil Engineer at the major command level disappeared.

Organizational changes within the civil engineer organization continued. In April 2007, the Air Staff was reorganized into the following five divisions: Asset Management and Operations (A7CA), Planning (A7CI), Programs (A7CP), Resources (A7CR), and Readiness and Emergency Services (A7CX).[78] The new Asset Management and Operations Division consolidated the following functions: housing, installation management, energy, and environmental quality and restoration. This division was tasked to develop a "blueprint for a new asset management approach across the CE enterprise."[79]

Figure 6.2 The Office of The Civil Engineer Organizational Chart, 2006



Source: AF/A7C Organizational Chart, October 20, 2006, AFCEC History Office.

The Planning Division incorporated most of the former Programming Division. A new branch within Planning, the Strategic Initiatives Branch, handled strategic planning and communications, and spearheaded the civil engineer transformation effort.[80] By 2010, the Air Staff A7 Divisions numbered six. The Housing Division was formed on September 10, 2010 when housing moved from the Asset Management Division. This division allowed housing personnel to focus on customers and demonstrated civil engineering commitment to quality housing, dormitories, and thriving communities.[81]

The major commands were directed to reorganize between early 2007 and the end of 2008. The proposed new major command organizational structure had eight divisions. These divisions were Asset Management (A7A), Contracting (A7K), Civil Engineer Operations (A7O), Programs (A7P), Resources (A7R), Security Forces (A7S), Readiness and Emergency Management (A7S), and Expeditionary Combat Support (A7Z).[82] ACC and AMC adopted the basic eight-division structure during 2007. Other major commands adapted the structure to meet their organizational requirements.[83]

Personnel Evolution

Several changes occurred in civil engineering personnel history. In January 1999, Mr. Michael A. Aimone became the first civilian Air Force Deputy Civil Engineer in the Pentagon, upon his selection to the ranks of the Senior Executive Service (SES). Previous senior Air Force Civil Engineer civilians were known as Associate Civil Engineers, and Deputy Civil Engineers were general officers. In spring 2002, Ms. Kathleen I. Ferguson, who was promoted to the ranks of the SES in June 2000 as the Chief, Combat Support Division, Directorate of Supply, succeeded Mr. Aimone as the Air Force Deputy Civil Engineer at the Pentagon. This office was the highest position in the Air Force civil engineer organization attained by a woman.[84] Ms. Ferguson served in the position until her 2007 appointment as Deputy Assistant Secretary of the Air Force (Installations) in the office of the Assistant Secretary of the Air Force.[85] She was succeeded by Mr. Paul Parker, who was previously the AFCEE Director. He served until 2010, when he moved to become the Director of Communications, Installations and Mission Support, Headquarters, Air Force Materiel Command. He was followed by Mr. Mark A. Correll, who had recently retired from active duty as the Civil Engineer at Air Education and Training Command.[86]

By 2002, the Air Force civil engineer organization included four SES positions: the Deputy Civil Engineer at Headquarters, U.S. Air Force, Washington, D.C.; the Director of AFCEE at Brooks AFB, Texas; the director of the Air Force Base Conversion Agency, Arlington, Virginia; and, Deputy Command Civil Engineer at Air Force Materiel Command (AFMC), Wright-Patterson AFB, Ohio. The SES position at AFMC previously was staffed by active duty military personnel.[87]

Women rose to higher administrative and command levels in the civil engineer organization. In summer 2002, Col. Faith H. Fadok was assigned as the mobilization assistant to The Civil Engineer at the Headquarters, U.S. Air Force, Pentagon.[88] Col. Beth Brown, served at the Pentagon as the chief of the Programs Division and became the Associate Civil Engineer in July 2010.[89]

Col. Janice M. Stritzinger served as the ANG Civil Engineer between 2001 and 2005.[90] Colonel Stritzinger achieved a number of "firsts" during her distinguished military career. Colonel Stritzinger enlisted in the Air Force in 1971 and was among the first women to enter the career field of site development specialist. She was the first woman assigned to an engineering specialty in the Alaskan Air Command. Colonel Stritzinger joined the ANG in 1977 and was assigned to Kulis ANG Base in Alaska. There she became the ANG's first female base civil engineer and fire marshal. In 2000, she became the first woman to serve as the Civil Engineer at ANG.[91]

Col. Theresa Carter was the first woman in the civil engineer organization to rise to the rank of brigadier general in May 2010 and major general in August 2013. Col. Carter became the Director of Installations and Mission Support at AMC during 2008 and the Commander, 502d Air Base Wing, Joint Base San Antonio in 2011. In June 2013, she became The Civil Engineer, also the first woman to hold that position. This selection marked the completion of the work begun in 1971 when Lt. Susanne Ocobock (Waylett) became the first female civil engineer.[92]

In 2003, the first civilian was appointed as the Civil Engineer of a major command. Mr. James R. Pennino, SES, became the Civil Engineer at AFMC after serving as deputy.[93] Mr. Timothy K. Bridges, SES, was appointed the Civil Engineer at AFMC after the retirement of Mr. Pennino. Mr. Bridges became the Deputy Assistant Secretary of the Air Force for Energy, Environment, Safety, and Occupational Health, at the Pentagon, Washington, D.C., in 2010 and moved to become Deputy Assistant Secretary of the Air Force for Installations, Office of the Assistant Secretary of the Air Force for Installations, Environment and Logistics, Washington, D.C. in 2012.[94]

Challenges to the retention of good military and civilian personnel were addressed during the first decade of the twenty-first century. Senior Air Force civil engineer leadership analyzed the obstacles to retaining qualified younger officers and identified four areas, or pillars, leading to long-term military commitment. The four pillars were leadership, deployments, professional development, and balanced living.

Younger officers, when polled, expressed greater need for direct mentoring and guidance from higher grade officers. While email had emerged as a convenient and expedient method for communication between officers, Maj. Gen. Timothy A. Byers supported more "high tech and high touch" leadership. He decided to make extensive use of Facebook and Twitter for the first time as a method to communicate at all levels and provide commanders tools to be personally engaged with the units. Personal guidance was related to job satisfaction and retention. Continual deployments were another concern identified in officer retention. Frequent deployments limited or disrupted professional development opportunities at home stations. Young officers also wanted a balanced lifestyle that provided time for the important role of relationships with family and friends, as well as time to recuperate and reenergize after deployments. Senior civil engineer leadership initiated a program to address these issues. They conducted company grade officer and field grade officer forums to hear from folks in the field about potential reasons they would leave the Air Force. Some of these such as improved mentoring and new opportunities for continuing education began to make a difference when communicated back to the field.[95] By 2011/12, the Civil Engineer retention rate for enlisted and officers was at a 17-year high.

Dirt Boy selected as Chief Master Sergeant of the Air Force.

CMSgt James A. Roy made history when he was chosen to serve as the 16th Chief Master Sergeant of the Air Force in June 2009 and became the first civil engineer to hold that position. CMSgt Roy began his career in 1982 as a heavy equipment operator and served in Civil Engineer squadrons at MacDill AFB, Florida; Osan AB, Korea; Andersen AFB, Guam; and Keesler AFB, Mississippi. He also served as an instructor at Ft. Leonard Wood, Missouri, where he trained other "Dirt Boyz." In 1999, he branched out into new leadership positions and was the Senior Enlisted Leader and Adviser, U.S. Pacific Command just prior to his selection as Chief Master Sergeant of the Air Force. Although he left civil engineer units in 1999, he never forgot his roots. When he retired from the Air Force in April 2013, CMSgt Roy reflected back on his career, "I started my technical training in November 1982. More than 30 years later, I still sincerely appreciate what civil engineers do. I'll always be a dirt boy."[96]


CMSgt James A. Roy

Program Budget Decision (PBD) 720

When Air Force Chief of Staff, Gen. T. Michael Moseley took office on September 2, 2005, "he inherited an Air Force with old weapons systems and an under-funded modernization program, and he directed program funding changes to replace our aging weapon systems," reflected Maj. Gen. Del Eulberg.[97] Program Budget Decision (PBD) 720, the Air Force Transformation Flight Plan, issued on December 28, 2005, was designed, with Congressional approval, to reduce manpower authorizations across the Air Force and to direct those savings towards retiring aging aircraft and acquiring upgraded aircraft and weapons systems to maintain air superiority.[98] The manpower reductions under PBD 720 affected 40,000 active duty, 17,000 ARC members, and 2,000 civilians.[99] While attrition through retirement and separation was anticipated to contribute to achieving the lower personnel levels in PBD 720, Air Force-wide personnel reductions of 20,000 also were required by FY07.[100] The first reductions were linked with the FY07 budget as a MILCON investment strategy to support Air Force transformation.[101]

Air Force civil engineer manpower authorizations were reduced by 1,586, comprising 1,408 enlisted personnel and 178 officers. Civil engineer civilian personnel were reduced by 271.[102] The Civil Engineer used PBD 720 as an opportunity for a Force Shaping Initiative to ensure that the right numbers of Airmen were performing the right jobs. The Force Shaping Initiative required reexamination of staffing levels and the organizational structure on the Air Staff, major command, and base levels.[103] The goal of this analysis was to rebalance the personnel force through reassigning Airmen from over-subscribed career fields to under-manned fields and through assuring that the appropriate grade levels existed within the fields. These decisions had consequences for training programs and career field development.[104]

In January 2006, The Civil Engineer authorized a team led by Lt. Col. Greg Cummings to conduct a personnel requirements review, also known as a blue suit review (BSR). The BSR team was guided by the draft 2006 QDR and the March 2005 National Defense Strategy. The operational defense strategy was based on the following parameters:

- homeland defense was the number one priority,
- military response could be required in an undetermined number of regional conflicts,
- simultaneous actions could be conducted in two of three major combat operations,
- winning decisively in one of those two major combat operations.[105]

The BSR team exhaustively reviewed war plans, time-phased force and deployment lists, and other documents in the vault at the Air Force Civil Engineer Support Agency (AFCESA) between January and May 2006. Based on these documents, the team quantified the appropriate manpower by Air Force Specialty Code, unit type codes (UTCs), and service component. The results of the rigorous review, completed in June 2006, validated current personnel authorizations and were used to identify areas for personnel cuts that would have minimal impact to warfighting capabilities. The results also enabled The Civil Engineer to avoid additional personnel cuts.[106]

The BSR found that three Air Force Specialties; i.e., heating, air conditioning, and refrigeration (HVAC); electrical; and, engineering assistant, were over-manned, while EOD and the structures and pavement and construction equipment career fields in RED HORSE were severely under-manned. A recommendation was advanced to rebalance the UTC wartime requirements to increase manpower in EOD and RED HORSE squadrons. The need for 159 additional personnel slots was identified in EOD to relieve the stress on that career field related to continual deployments. The BSR also identified 318 positions to strengthen RED HORSE units. These positions did not represent an overall increase in manpower authorizations, but were achieved through reductions in the number of military and civilian positions in other areas. The proposed increase in RED HORSE personnel came from realigning 185 positions in horizontal construction specialties and 133 in vertical construction specialties from Prime BEEF UTCs to RED HORSE squadrons. Although this rebalancing met wartime manpower requirements, peacetime personnel short falls were projected. The BSR recommended that civilian positions be added to replace lost military positions to support installation requirements.[107]

Process Evaluation

In January 2006, The Civil Engineer chose then-Lt. Col. Jeff Todd to lead a team to examine restructuring the civil engineering force and to transform business processes throughout the civil engineering organization. The team was charged with identifying initiatives to offset and to lessen the effects of personnel reductions under PBD 720 through applying business practices to achieve increased operating efficiencies. The team proposed several initiatives to consolidate selected organizational functions.[108] These initiatives then were incorporated into the *Civil Engineer Transformation Plan*.

Civil Engineer Transformation Plan

The initiatives developed by the BSR team and the team reviewing business processes were integrated into the *Civil Engineer Transformation Plan*. The plan applied to all active military organizations but exempted the ARC. The plan sought "to minimize the impact of PBD 720 reductions; maintain CE support to the installations; increase combat capability based on requirements identified in the 2006 Quadrennial Defense Review; and, balance CE capabilities across the Air Force."[109] The plan's initiatives also met the spirit of AFSO21.

The draft Plan was presented to the Vice Chief of Staff of the Air Force in late summer 2006 and approved on October 19, 2006. The final version of the *Implementation of Civil Engineering Transformation Plan* (Program Action Directive (PAD) 07-02) was issued in April 2007. The initiatives central to the Plan were:

- Centralizing control for all current and new mission military construction,

housing MILCON, and environmental restoration projects at the Air Force Center for Environmental Excellence (AFCEE);
- Issuing a new fire emergency services concept of operations that reduced the number of firefighters;
- Realigning 600 military positions from AFMC;
- Augmenting EOD and RED HORSE personnel;
- Reorganizing all organizational structures on the Air Staff, major commands, and specifically at the base level.[110]

These initiatives were to be accomplished by October 1, 2008.[111]

During 2008, management for all current and new mission MILCON, housing MILCON, and environmental restoration account funds was consolidated at AFCEE. Since 1991, civil engineers at major command headquarters had managed construction and environmental remediation projects. Civil engineers at the major commands retained the functions of programming the construction requirements, determining the construction priorities, and advocating for funding. All funding was centralized on the Air Staff level. Consolidating the functions at AFCEE reduced staffing at major commands by 200 positions.[112] Beginning FY08, AFCEE added 129 personnel to handle the expanded work load.

Review of the firefighting personnel requirements revealed that the Air Force maintained a high number of firefighters on continuous call to meet emergencies. Patterns defined through an analysis of the number, types, and hours of emergency calls identified specific periods of high and low risk and related demand for emergency services. Acceptable risk analysis demonstrated that the existing level of service and response standards were achievable during high risk periods, typically normal working duty hours. Fewer, but adequate, resources were needed during low risk periods, which typically occurred at night. The detailed study found that the number of on-duty firefighters could be reduced during periods of low probability for base emergencies. This resulted in a reduction of firefighters by 901 positions or 14 percent.[113]

AFMC maintained military-manned Civil Engineer Groups at three bases: Robins AFB, Georgia; Eglin AFB, Florida; and, Hill AFB, Utah. The Civil Engineer proposed that AFMC convert these three organizations to civilian staffing. The Air Force realigned 615 military personnel to other major commands to preserve military authorizations and maintain UTCs. In addition, 258 civilian positions were proposed to assume the work load. AFMC was afforded flexibility in developing an organizational structure to increase efficiencies in managing work flow.[114] A few military positions were retained at the bases, including firefighters, readiness, and EOD personnel. Mr. Timothy K. Bridges, Director of Installations and Mission Support since July 2006, noted, “Academically, it makes sense. Most of our activities are in the CONUS. We really don’t have warfighting platforms; we take care of everyone else’s platforms. The support we give our installations can be done by a civilian workforce.”[115] The transformation of the military work force at AFMC was projected to be achieved in two years.

Augmenting RED HORSE squadrons was accomplished during 2008 when then-Brig. Gen. Timothy A. Byers, ACC/A7, led efforts to reorganize engineer forces to support warfighter requirements. RED HORSE units were increased, active duty units were aligned with reserve component forces and RED HORSE squadrons were augmented with Prime BEEF engineers to meet deployment requirements to support CENTCOM engineer requirements. RED HORSE squadrons were actively sought to support heavy construction requirements for OEF and OIF. At any given time, one of ACC’s three RED HORSE squadrons was deployed. When deployed, RED HORSE squadrons were under the Commander, Air Force Forces at U.S. Central Command (USCENTCOM). ACC worked to add 318 personnel positions to the RED HORSE squadrons. Engineers from across the Air Force were offered the opportunity to join. The increase in the active duty RED HORSE personnel was supported by the addition of 446 RED HORSE authorizations in the Air Force Reserve. The new authorizations were made available by converting Prime BEEF teams at Charleston AFB, South Carolina, and Seymour

Johnson AFB, North Carolina, to RED HORSE squadrons and supplementing the units with reservists displaced through BRAC. The new RED HORSE squadrons were the 567th at Seymour Johnson AFB and the 560th at Charleston AFB. These RED HORSE squadrons continued to be associated with active duty Prime BEEF at their respective stations. Standing Reserve RED HORSE units, on the other hand, were associated with active duty RED HORSE squadrons to foster total force integration. The ANG also increased its RED HORSE staffing to full strength at 404-persons. In addition, the RED HORSE personnel and equipment UTCs were revised to develop more modular packages with lighter and leaner capabilities during deployment.[116]

Business Process Re-Engineering Initiatives

Air Force civil engineers adopted business re-engineering principles early during the twenty-first century and continued to review and streamline their work processes in all areas throughout the decade. The principles of "lean management" were adapted to civil engineering systems to streamline base-level maintenance and repair operations and general work processes. For example, the design-build process was one area where the principles of lean management particularly were applicable to Air Force civil engineering. In 2004, a tri-service working group examined existing MILCON design-build procedures and developed a plan to expedite projects and compress construction schedules. The working group proposed efficiencies and associated economies by reducing project time frames from 966 days to 599 days.[117] Air Force civil engineers implemented a Continuous Process Improvement/ Lean game plan to institutionalize the lean management within civil engineering. The game plan established a target for training in "Lean awareness" by April 2006 and for 100 process improvement events throughout that year.[118]

In 2005, The Civil Engineer also implemented the Facilities Operation Model at the direction of the Office of the Secretary of Defense (OSD). This model defined a programmatic methodology to forecast operating costs for emergency services, utilities, refuse collection, grounds maintenance, and custodial services similar to that used by municipalities. The Facilities Operation Model, based on the industry standard, was refined by Air Force for planning, programming, and budgeting for expenses that exceeded $1.3 billion per year.[119]

After issuance of the Air Force *Civil Engineer Transformation Plan* in 2007, Maj. Gen. Del Eulberg expanded civil engineer transformation initiatives to apply best business practices throughout the organization. A key aspect of transformation was "to reduce costs and improve the efficiency of the core business processes that underpin our mission support capabilities."[120] Private industry provided the operational models and prototypes for cost-effective civil engineer operations. "Looking closely at processes and workflows, then combining or streamlining them where possible, will garner civilian efficiencies that enable us to balance the workload with the right resources," wrote General Eulberg.[121] In late 2006, he established a Corps of Discovery to identify best business practices and automation tools used by private corporations. General Eulberg recognized the value of lessons gleaned from aligned civilian sectors. He did not send the Corps of Discovery to investigate leading architectural or engineering design firms, but directed investigation toward businesses managing large real estate portfolios and bankers. The Corps of Discovery derived five major objectives from the investigation:

- Manage real property from a portfolio perspective to avoid sub-optimization;
- Standardize business processes for the enterprise;
- Leverage best practices across the enterprise;
- Use automation and information technology to reduce costs and better utilize personnel resources; and
- Leverage the size of the CE enterprise through centers of expertise and strategic sourcing.[122]

General Eulberg and the Office of The Civil Engineer also conducted a series of workshops in early

2007 to analyze the high-level capabilities civil engineers required to carry out their mission. Subject matter experts defined core civil engineering responsibilities and correlated those responsibilities to business processes during the workshops. Major areas of a civil engineer's job were categorized as projects, work, supply, installation-level assets, enterprise-level assets and finances. During the workshops, the standard business practices and best business practices identified by the Corps of Discovery were presented to the participants. The workshops served two further purposes: to identify specific business process transformation initiatives and to define the civil engineer capabilities that must be supported by information technology in the future.[123]

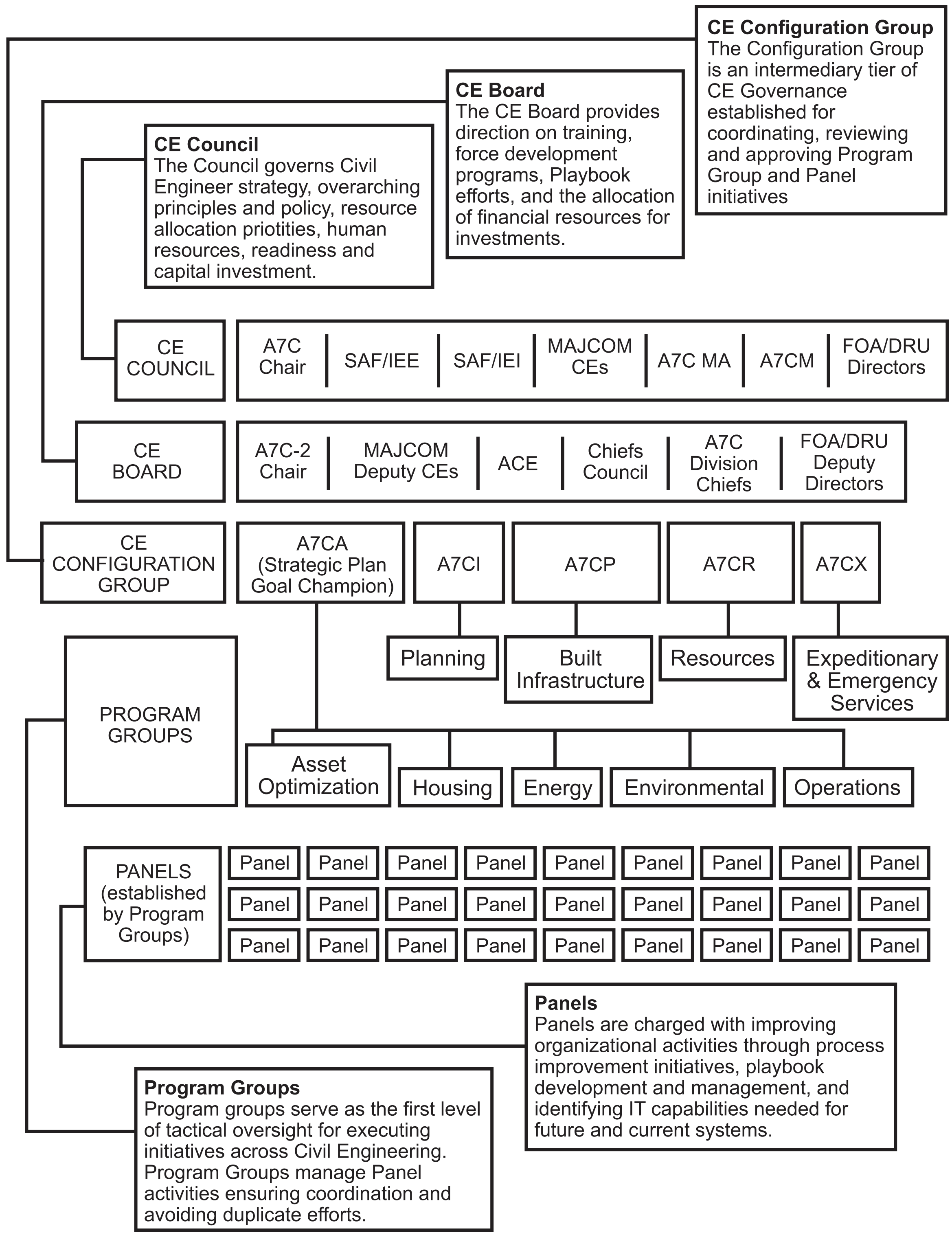
In April 2007, the Office of The Civil Engineer began work on a core set of transformation initiatives to focus re-engineering of the civil engineer business model. A poll of the major commands had found that over 200 individual transformation initiatives were underway. General Eulberg suspended further implementation of all initiatives pending a thorough review and evaluation. The Civil Engineer subsequently issued a list of 35 initiatives, of which the first 5 initiatives were from the 2007 *Civil Engineer Transformation Plan*. Points of contact for each commissioned initiative were established at the major commands and FOAs. General Eulberg charged each team investigating the 35 commissioned initiatives with clear responsibilities, expectations, guidance, and resources. The role of the teams was to report back their findings to The Civil Engineer.[124]

One initiative implemented by General Eulberg in 2007 was the adoption of the asset management approach to the civil engineer enterprise. General Eulberg defined asset management as "using systematic and integrated processes to manage natural and built assets and their associated performance, risk, and expenditures over their life cycles to support missions and organizational goals. Asset managers will be expected to apply a disciplined, deliberate approach to managing our asset portfolio in a more holistic and proactive manner than we've done in the past."[125] Adopting the asset management approach represented a major paradigm shift in the way civil engineers managed facilities and fostered a comprehensive strategy to utilize, optimize, and leverage Air Force assets to their fullest capacity. Assets were no longer defined as real estate, buildings, and housing, but expanded to include the natural environment and energy resources.[126]

As the number of ideas for transformation increased, The Civil Engineer recognized a need for organized and consolidated transformation management. By July 2007, a civil engineer transformation governance structure under the oversight of a Board of Directors was established at the Air Staff.[127] The board reviewed and vetted ideas and recommendations generated by the commissioned initiative teams and by individual Airmen. Once approved, governance structure recommendations were then implemented across the civil engineer enterprise.[128] In 2008, General Eulberg reflected that implementing all 35 transformation initiatives at the same time had been overly ambitious.[129] In 2009, General Byers approved a new Governance Structure to help communicate policy and doctrine, manage process and IT improvements, and execute initiatives (Figure 6.3). The establishment of Program Groups across the nine core business areas to ensure the review of processes to identify efficiencies was a key change in this structure.[130]

Civil Engineer Governance changed again when Program Action Directive (PAD) 12-03, "Implementation of Enterprise-Wide Civil Engineer Transformation," was signed in October 2012 as part of Civil Engineer Transformation—Accelerated (CET-A). Because of the myriad changes involved in CET-A, a new framework was established to allow MAJCOM and installation-level input to the Air Force Civil Engineer Center (AFCEC) investment plan development through the Installations Governance Structure. It did not replace the established Civil Engineer governance structure (Panels, Program Groups, Board, and Council). It provided a forum for considering MAJCOM vice commanders, Air Staff and Secretariat vision, priorities, and goals into Civil Engineer decisions and processes through the Installations Executive Council. Below the Installations Executive Council was the Civil Engineer Council, that included Deputy Assistant Secretaries for Installations, Energy, and Environment, Safety,

Figure 6.3 Civil Engineer Transformation Governance Structure, 2010



Source: Maj. Gen. Timothy A. Byers, "Connecting the Transformation Dots," Air Force Civil Engineer, Vol 18, No 1, 2010, 10.

and Occupational Health; the new AFCEC Director; and MAJCOM A7s, A4/7s, and A6/7s as appropriate. The council reviewed and approved Air Force requirements and priorities for execution based on the Installations Executive Council's guidance. The Installations Integration Group integrated all requirements to create the Air Force Activity Management Plan and Air Force Comprehensive Asset Management Plan. (Figure 6.4)[131]

Communication was critical to successful transformation management and necessary to inform involved parties of the goals, objectives, and results of the process. A wide variety of materials were disseminated to the civil engineer community to facilitate communication. These materials included a Civil Engineer Transformation Governance Playbook issued in July 2007, a community of practice website dedicated to transformation topics, a transformation dashboard, informational videos, and a special edition of the *Air Force Civil Engineer* magazine.[132] In addition, regular communications were maintained between the Office of The Civil Engineer and the major commands. General Eulberg encouraged the major commands to share ideas and to learn from each other during the transformational process. He suggested that civil engineers apply the ideas of other commands in improving and transforming their organizations.[133] New media also were employed. By 2009, the Air Staff's Strategic Initiatives Branch launched a civil engineer web portal. The web portal provided access to the business process playbooks, civil engineering news, a range of interactive resources, publications, and new tools to support transformation.[134]

Figure 6.4 Civil Engineer Transformation Governance Structure, 2012

Provides Strategic Guidance, Priorities, Vectors and Metrics to ensure AF installation complex viability. Incorporates results from various ESGs and other strategic guidance to shape strategic direction.	**Installations Executive Council (IEC)**	Chair(s): **SAF/IE and A4/7**	Participants: **A7C, IEI, IEE, IEN, FOA Director Advisors: AQ, SB, FM, GC, JA, ACS, CFLI, MAJCOM/CVs (also representing CFLI role; 2x/year)**
Approves AFCAMP (2 Year Investment Plan). Reviews/Approves AFAMP (FYDP Requirements Plan). Ensures AFCAMP aligned with the IEC vision, ESG directions and other strategic guidance; balances financial and risk decisions. Receives regular PMRs from FOA, adjusts exectuion plan as necessary.	**Civil Engineer Council**	Chair(s): **A7C & IEI*** (IEI co-chairs as appropriate - otherwise,IEI is a participant)	Participants: **FOA Director, IEI*, IEE, IEN, ISP Chair, CFLI (Rep.), FOA Planning and Integration Director, A7 or A4/7 or A6/7 Advisors: AQ, SB, FM, GC, JA**
Develops AFAMP (FYDP Requirements Plan). Integrates all "Product Line" requirements, opportunities, and initiatives into supporting AFCAMP. Ensures investment plan aligned w/IEC and CE Council vision. Recommends "risk" & funding decisions. Provides regular updates to CE Councils.	**Installation Integration Group (I2G)**	Chair: **FOA Director**	Participants: **FOA Product Line Directors, AMP Integrators, AMP/Portfolio Managers, MAJCOM Reps Advisors: AQ, SB, FM, GC, JA**

Source: "Headquarters USAF Program Action Directive 12-03, Implementation of Enterprise-Wide Civil Engineer Transformation," October, 26, 2012, 14.

Civil Engineer Transformation: 20/20 by 2020

The phrase “20/20 by 2020” became a slogan for Air Force civil engineer transformation. The first “20” represented the 20 percent reduction in installation funding imposed between FY06 and FY07. The Air Force goal was to offset the reduction through improved operational efficiency in re-engineering base processes and practices. The second “20” reflected the goal to reduce the Air Force physical plant, and subsequent maintenance costs, by 20 percent. This was necessary because the 2005 BRAC effort did not reduce the Air Force’s infrastructure to a level that matched the smaller infrastructure funding. General Eulberg sought to shrink the infrastructure from within through demolition, utilities privatization, and enhanced use lease efforts. Air Force funding was to be used to operate only the infrastructure needed to “to perform Air Force missions, diverting resources away from excess, obsolete, and under-utilized infrastructure capacity.” These goals were to be accomplished by the year 2020.[135] A goal of zero net growth was established for the Air Staff and major commands to eliminate the overall growth of square footage of buildings and structures at the bases. Zero net growth was monitored beginning in FY07 by tracking square footage added through new construction compared to the area decreased through the demolition of obsolete buildings.[136] As General Eulberg projected,

> Our goal is to achieve efficiencies to offset the 20 percent reduction in funds available for installation support activities, and reduce the amount of the Air Force physical plant we spend money on by 20 percent by the year 2020. Collectively, our transformation efforts will enhance support for the warfighters, reduce the cost of installation engineering activities, and free resources for the recapitalization of Air Force weapons systems.[137]

Civil Engineer Strategic Plans

The Air Force civil engineering community continually revised its strategic plan to reflect the priorities of the Secretary of the Air Force and DoD. The 2004 civil engineer strategic plan established key planning priorities and transformational goals, which reflected the DoD installations strategic plan goals “to achieve a balance between resources, capabilities, capacities, and military requirements.”[138] The civil engineer strategic plan was updated in 2005 and was designed as a dynamic document developed with the participation by Air Staff, major commands, and FOAs. However, shortly after its publication, further revisions to the strategic plan were suspended until the implementation of staff reductions and process improvements.[139]

Work resumed on strategic planning documents in 2008. The 2008 plan issued by the Office of The Civil Engineer revised the mission statement, goals, and objectives of the organization. In addition, the plan outlined methods for civil engineer support for the larger Air Force and DoD goals. AFCESA and AFCEE also published strategic plans for their organizations. These latter plans were made available to all Airmen through the website called “Air Force Knowledge Online.”[140]

In late 2008, the Secretary of the Air Force and Air Force Chief of Staff released a new Air Force strategic plan; the Office of The Civil Engineer began to update its strategic plan. The revised civil engineer strategic plan covered the period 2009 through 2013 and aligned priorities with those of the Air Force. The revised plan summarized projects completed since 2008 and introduced new objectives.[141] The goals of the plan were to “increase readiness and support to the warfighter, strengthen our total force, and develop and maintain sustainable installations.”[142]

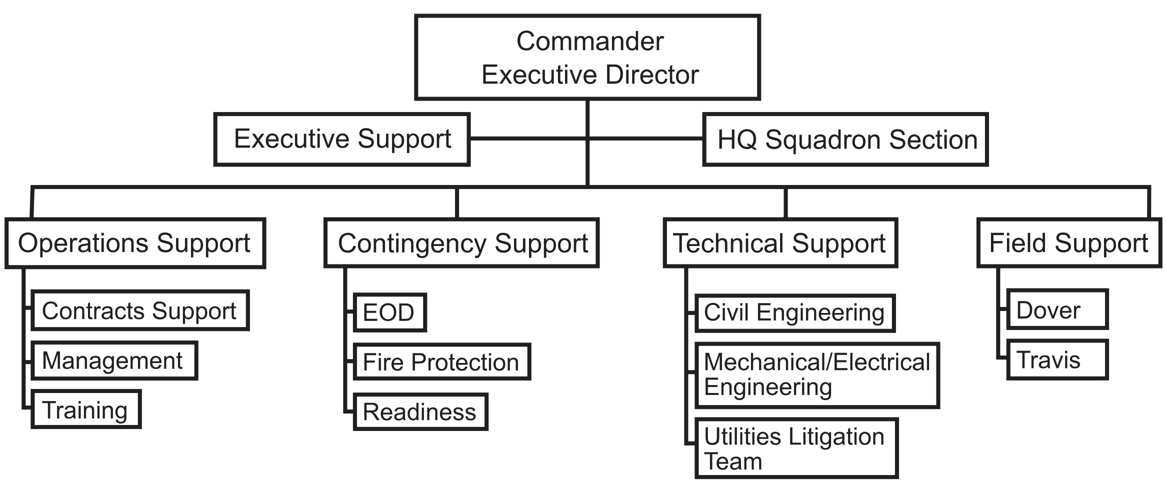
Maj. Gen. Timothy A. Byers, appointed The Civil Engineer in June 2009, and the senior civil engineer leadership reviewed the proposed 2009-2013 civil engineer strategic plan to ensure that it met then-current Air Force goals. General Byers commented on the utility of the latest document: “We have integral roles in everything that the CSAF and the SECAF laid out under their five priorities, and now have a map, if you will, of how we're linked."[143] The revised 2009-2013 civil engineer strategic plan aligned with the Air Force's priorities: reinvigorate the nuclear enterprise, partner with the Joint and Coalition team to win today's fight, develop and care for Airmen and their families, modernize our air and space inventories, and restore acquisition excellence. It also reflected the fiscal and economic challenges facing the nation following the economic slowdown of 2008. The Strategic Plan codified the three following goals that became General Byers' framework for his time as The Civil Engineer: Build Ready Engineers, Build Great Leaders, and Build Sustainable Installations. The Strategic Plan also included the Civil Engineer Governance Structure discussed above, approved in September 2009.[144]

AFCESA Developments 2001-2011

The Air Force Civil Engineer Support Agency continued to extend broad-based support for the civil engineering community from the Air Staff to the base levels. The agency afforded expertise in readiness, emergency services, energy, utilities, contracting, and automation, as well as fielded the Airfield Pavement Evaluation team and Civil Engineer Maintenance, Inspection, and Repair Team (CEMIRT). AFCESA personnel were a source of technical guidance on policies for the Air Staff and provided services to base operations. AFCESA continued to serve as the Program Manager for AFCAP.

In 2000, AFCESA, under the leadership of a Commander and Executive Director, was organized into four main directorates: Operations Support, Contingency Support, Technical Support, and Field Support (Figure 6.5). In 2001, the Operations Support Directorate was restructured and expanded from three divisions to four. The three initial divisions were Contracts Support, Management, and Training. The fourth division, added in October 2001, was the Technology Integration Division. The new division consolidated responsibility for technology related to the Operations Flight in the civil engineer squadron at each Air Force base, including the Automated Civil Engineer System, the Installation Data Warehouse, and GeoBase. The Contracts Support Division was renamed the Utilities Privatization Directorate during the same reorganization and focused exclusively in that area. Another new division was the Knowledge Management Division, which was responsible for A-76 competitive outsourcing and contracting operations previously assigned to the Contracts Support Division. The Knowledge Management Division also assumed the management of other programs that affected the base Operations Flights, such as vehicles, financial management, and real estate. The Training Division was renamed the Force Development Division and was expanded to include career field management positions for the Civil Engineering Air Force Specialty Codes.[145]

Figure 6.5 AFCESA ORGANIZATIONAL CHART, 2000



Source: History of the Air Force Civil Engineer Support Agency, 1 Jan-31 Dec 2000, Appendix D.

On September 11, 2001, AFCESA personnel responded to the terrorist attacks in New York City, and Washington, D.C. AFCESA's Readiness Center, renamed the Readiness Operations Center at Headquarters, AFCESA in August 2001, was activated on a 24-hour basis. This alert lasted until September 24, 2001. AFCESA dispatched a representative to the command post of the Southeast Air Defense Sector headquarters, North American Aerospace Defense Command, which assumed control of all U.S. airspace. Col. Bruce Barthold, AFCESA Commander, was at Ft. Leonard Wood, Missouri, at the time of the attack and had to return to AFCESA by rental car. Mission-essential personnel reported to work on September 12 and on the morning of September 13. Regular working hours were resumed at noon on September 13, 2001, with the exception of personnel working in the vault.[146]

Throughout the decade, AFCESA personnel strove to meet the agency's mission: "Provide the best tools, practices, and professional support to maximize Air Force Civil Engineer capabilities in base and contingency operations."[147] The agency supported Air Force civil engineers worldwide at 82 major and 10 minor active-duty installations, 83 Air Force Reserve and Air National Guard installations, and deployed locations worldwide.[148]

AFCESA continued to focus on disseminating information throughout the civil engineer community; one of AFCESA's primary roles was to provide answers. As AFCESA Commander Col. Gus G. Elliott, Jr., described AFCESA's efforts, "If you have a question…We have the answer. If you have a problem…We have the solution."[149] Information was disseminated through a wide variety of media. Previously printed materials were distributed in electronic formats. On April 1, 2002, AFCESA began publishing A-Grams only in electronic format accessible through an internet website.[150] The A-Grams offered useful advice and instruction on a range of topics useful to civil engineers.

AFCESA also facilitated communication using the World Wide Web through the creation of a knowledge management program to support its customers. One component of the program was Communities of Practice (CoPs) launched in 2004. By summer 2005, 18 CoPs related to civil engineering topics had been accessed by more than 3,000 members. CoPs were hosted by the web platform "Air Force Knowledge Now" managed by AFMC. Popular topics included full spectrum threat response and contingency engineering. Through these virtual workspaces, CoP members queried for advice and reviewed best practices.[151] By 2008, CoPs became a vital tool for Air Force civil engineers, whether deployed or resident at home stations. CoPs evolved into an easily accessible method of communication, a tool to capture lessons learned, and a source of pragmatic information on a selected number of topics. By 2008, the AFCESA webmaster maintained the CoPs Index.[152]

The AFCESA Reach-Back Center, established in April 2005, was a telephone call center that forwarded questions to the appropriate subject matter expert and tracked inquiries to their successful resolutions. The center was available to all Air Force civil engineer personnel worldwide, whether at home stations or at deployed locations. The objective of the Reach-Back Center was to assure "customers access to subject matter experts every time they call or e-mail for support." Information was available on "products, methods, training, criteria, templates, checklists, etc., in thousands of program areas that supported base or contingency missions."[153] The new center featured a computer system to track expert responses. Many of AFCESA's 75 subject matter areas were manned by single experts. The center facilitated access to these experts. AFCESA promised "accurate, prompt, and decision-quality" answers within hours, or at most, three days. By summer 2005, the Reach-Back Center had fielded 800 calls; the average turn-around time for responses was six hours.[154] By 2007, the volume of inquiries reached over 20,000. The center was managed initially by a team of three contractors, and, by 2007, had expanded to include a dedicated two-person emergency management help desk. The new help desk was assisted by the AFCESA Readiness Operations Center.[155]

In late 2004, management of the Sustainment, Restoration and Modernization (S/R&M) program was transferred from AFCEE to AFCESA. S/R&M was a budget line item in the overall Air Force budget under the Operations and Maintenance accounts dedicated to modernizing Air Force facilities and infrastructure. The transition occurred over a year and was completed by October 2005. During that year, AFCEE handled overseas projects, while AFCESA handled CONUS projects. The new responsibilities assigned to AFCESA required setting up a new directorate, Installation Support, which comprised four divisions: POL/Fuels, Vertical, Pavements, and Utilities.[156] S/R&M projects involved "maintenance, repair, and construction upgrades to existing facilities and infrastructure on Air Force bases." AFCESA staffed its management team from in-house project managers and drew upon in-house subject matter experts in electrical, mechanical, civil engineering, and architectural disciplines, as well as airfield pavements, structural, fire engineering, cathodic corrosion protection, and seismic engineering, among others.[157]

AFCESA's first real test in managing the S/R&M program occurred in the aftermath of Hurricane Katrina in 2005. AFCESA directed S/R&M funds to recovery work at Keesler AFB, Mississippi, which was damaged severely by the storm. In FY05, AFCESA awarded a total of $145 million in S/R&M contracts, of which $91 million assisted the recovery at Keesler AFB. The S/R&M contract awards grew to more than $350 million for FY06. As Keith Cutshaw from the 16th CES at Hurlburt Field, Florida, reported,

> The beauty of the S/R&M contracts is that full-blown designs are not required. All it takes to get a project underway is to send the funds to AFCESA and provide a statement of work, typically a 35 percent design. Once a contractor is selected and the project awarded, we manage the day-to-day construction activities locally. It may cost a little more using the S/R&M program, but you receive the additional support from AFCESA in administering the contracts and the contractors actually develop the implementation plan.[158]

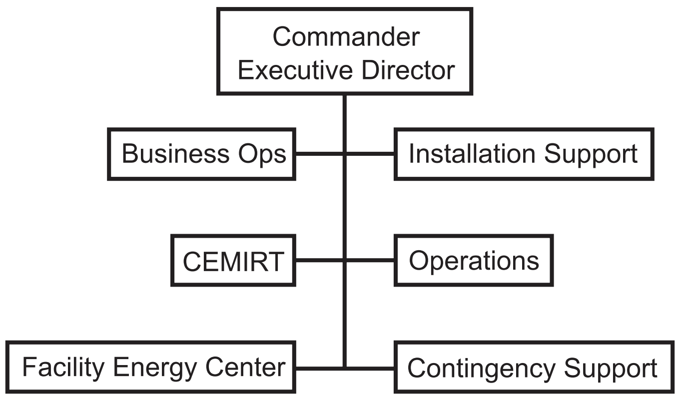
Between 2005 and 2007, AFCESA issued S/R&M awards through AFCEE's indefinite delivery/indefinite quantity (ID/IQ) contracts. In January 2008, AFCESA set up its own ID/IQ contracting vehicle entitled the S/R&M Acquisition Task Order Contract (SATOC). SATOC was capped at $4 billion and 16 companies were selected as contractors. SATOC made possible a variety of contracting options, including turnkey, design/build, concept work plan/implementation work plan, and design-bid-build.[159] In 2007, SATOC was the contracting vehicle for 230 projects valued at $325 million and executed for all Air Force major commands.[160] In 2009, $443.5 million were awarded through AFCESA's SATOC for work at 58 bases.[161]

By early 2007, the organizational structure of the agency had grown to six directorates: Contingency Support, Engineering Support, Field Support, Operations Support, Installation Support, and Business Operations Support.[162] During summer 2006, Col. Richard A. Fryer, Jr., transferred from the position of Executive Director at AFCEE to become the Commander at AFCESA.[163] AFCESA underwent a period of transformation. The organizational structure was revised into the following directorates: Mission Support, Contract Support, Facility Energy Center, Field Support, Operation and Program Support, and Readiness Support (Figure 6.6). Four hundred and six persons worked at the agency. Personnel comprised 84 active duty military, 23 Reservists, 102 civilians, and 195 contractors. During the period from 2008 and 2009, the number of persons employed at AFCESA decreased by approximately 20, but rebounded to 404 in 2010. This staff included 81 active duty, 163 civilians, and 161 contractors. AFCESA was led by a series of Commanders during the period: Col. Richard A. Fryer, Jr. (2006-8), Col. Max E. Kirschbaum (2008-10), and Col. David L. Reynolds (2010-12).[164]

AFCESA continued in its role of support to the Air Staff, major commands, and the bases; it was a critical partner facilitating and supporting Air Force civil engineer transformation. In February 2007, General Eulberg announced a concerted effort to maximize lessons learned in all areas of civil engineer enterprise, from contingency deployments to transformation initiatives, by capturing the experiences of Airmen. He appointed AFCESA as the central location for the Air Force Civil Engineer Lessons Learned Program. AFCESA served as the central repository for the collection, and validated, tracked, and disseminated civil engineer lessons learned. Non-classified lessons learned were made available through the Advanced Lessons Management System accessible over the web or the Lessons Learned CoP. The AFCESA Reach-Back Center was the primary vehicle for disseminating classified lessons learned.[165]

In February 2007, AFCESA created the Air Force Facility Energy Center (AFFEC). Energy had been a part of AFCESA's mission since the mid-1970s and became a major product area for the agency in the twenty-first century. The AFCESA Energy Team had been active since 2004 and served as the nexus for energy issues among Air Force bases. The team incorporated experts in contracting, finance, energy awareness, energy audits, training, and renewable energy. The team also supported installations

Figure 6.6 AFCESA Organizational Chart, 2007



Source: History of the Air Force Civil Engineer Support Agency, 1 Jan-31 Dec 2007, Appendix D.

in developing renewable energy projects.[166] AFFEC was established to manage all facility energy and water conservation programs, as well as to identify funding methods and viable technologies.[167] AFFEC also monitored the Air Force's progress in meeting the 2015 energy goals mandated by the Energy Independence and Security Act of 2007.[168] In this role, AFFEC assisted installations to meet "Federally mandated energy efficiency improvement goals by securing reliable and affordable energy through facility energy management, energy savings performance contracts, renewable energy, utility rates litigation, and utility privatization."[169] In 2007, AFFEC developed a Facilities Energy Strategic Plan.

Readiness and operations along with energy were the three core competencies identified in AFCESA's 2011 informational brochure. These competencies served to "enhance mission capability and warfighter support."[170] AFCESA provided major readiness support in overseas contingency operations. Its team of engineers, firefighters, and emergency management and EOD specialists worked in the field and alongside deployed civil engineer personnel to solve critical problems and issues. In operations, AFCESA provided the same expertise to support maintenance and operations challenges and emergency situations at permanent Air Force bases worldwide.[171]

<u>Airfield Pavement Evaluation Team</u>

One area of AFCESA expertise was the evaluation and repair of airfield pavements. The Airfield Pavement Evaluation (APE) team continued to support Air Force missions in CONUS and overseas. The 12-member team (broken down into three or four-person teams for inspections) was responsible for evaluations of contingency and peacetime runways at 200 installations.[172] During evaluations, teams extracted core samples of pavements to determine the thickness and concrete flexural strength. The teams then completed tests of the underlying soils. APE teams also performed structural analysis of the runways to determine their ability to support varying aircraft. The teams also employed a heavy weight deflectometer, a unique trailer-mounted machine to forecast potential pavement failures based on different aircraft.

In February 2001, the APE team purchased a new "specialized contingency pavement evaluation vehicle."[173] The 12,500 pound vehicle was outfitted with a core drill and automated dynamic cone penetrometer, which allowed teams to extract core samples from the stationary vehicle.

Team members were actively engaged in the overseas contingency operations during the first decade of the twenty-first century. Six members of the APE team deployed to SWA to evaluate theater airfields in 2001 in preparation of OEF. The team deployed with 21 short tons of equipment and evaluated sites in six countries.[174] Some airfields evaluated by the pavement team included Pasni and Jacobabad in Pakistan; Karshi-Khanabad AB, Uzbekistan; Manas International Airport, Kyrgyzstan; and, ten airfields in Afghanistan. Pavement thickness and the underlying soils were assessed by the APE team to determine the weight limitations for aircraft and the number of flights that could be supported from each airfield.[175]

In 2003, the results of a pavement assessment at Grand Forks AFB, North Dakota, necessitated quick rehabilitation or reconstruction of the 47-year old runways. The resulting $27.5 million runway construction project was the largest Air Force O&M project issued that year. Following a year of design consultation among contractors, AMC's Infrastructure Branch, and the U.S. Army Corps of Engineers' Transportation Systems Center, a design approach utilizing rubblization was agreed upon. Rubblization was a process using extant pavement materials as the base foundation for a new pavement. The process was cost-effective and environmentally sound.[176] A construction innovation for installing concrete in sub-zero temperatures was introduced during the runway project applying antifreeze admixture technology. The poured concrete cured properly at air temperatures of 25 degrees Fahrenheit and attained the prescribed compressive strength in four days without heat.[177] The runway officially opened on November 7, 2005.[178]

The AFCESA Airfield Pavement Evaluation Team uses a dynamic cone penetrometer to evaluate a runway at Kandahar, Afghanistan.

Dover AFB, Delaware, completed one of the largest AMC airfield rehabilitations in 2009. The runway, first constructed in 1943, had deteriorated over time due to continual use exacerbated by the chemical reaction between Portland cement and aggregate. The rehabilitation project area required the removal of 472,989 square yards of pavement. Nearly 70,000 tons of the removed pavement were recycled and used in the construction of overruns, shoulders, and staging areas. The new concrete pavement was the equivalent of 47.2 miles of 20-foot wide lanes.[179]

Airfield Damage Repair

At the request of the combatant commanders, AFCESA formed an airfield damage repair (ADR) working group to evaluate Base Recovery After Attack (BRAAT) and Rapid Runway Repair (RRR) methods for use in Southwest and Central Asia. Interest in runway repair techniques was revived when it became crucial to maintain airfields at forward bases in hostile environments. In Iraq and Afghanistan, incoming mortar and rocket attacks damaged runways that then required repairs. In other cases, Air Force civil engineers needed to restore runways damaged either by U.S. attacks or by retreating enemy troops. Air Force civil engineers were using the same RRR techniques since 1985, and current experiences proved that airfield damage repair techniques needed to be broadened beyond RRR and BRAAT. Airfield repairs were still being completed using folded fiberglass panels and even AM-2 matting. AFCESA and the ADR working group collaborated with several DoD laboratories to develop new materials, new techniques, and new equipment to accomplish airfield damage repair.[180]

In 2008, Critical Runway Assessment and Repair (CRATR) was introduced. CRATR was established as a joint-service program involving the Air Force and U.S. Pacific Command to identify methods to improve airfield recovery operations using new techniques and materials. CRATR emphasized remote capabilities designed to protect service members in the field. One aspect of CRATR was the Rapid Airfield Damage Assessment System that employed remote sensing technology and geographic information system mapping tools to perform minimum airfield operating surface reconnaissance.[181] Other techniques and equipment advanced by CRATR were the multi-terrain loader, a small, maneuverable vehicle that could be used to cut through 18 inches of concrete and haul it away, and high-density foam that expanded up to eight times its original volume in a matter of minutes.[182] Three demonstrations were held between August 2008 and August 2009 showcasing CRATR methods.

CEMIRT

The Civil Engineer Maintenance, Inspection, and Repair Team (CEMIRT) continued to provide power production, aircraft arresting system overhaul, HVAC, and controls services throughout the decade. In 2001, CEMIRT supported Operation Southern Watch in Saudi Arabia and Kuwait. Personnel completed annual inspection and repair of Harvest Falcon power production systems. Installations around the globe received assistance from CEMIRT in a variety of power production areas, including troubleshooting/repairing automatic transfer systems, upgrading power plants, installing and overhauling generators, emergency repair of electrical substations, airfield lighting, and maintenance and repair of aircraft arresting systems.[183] During the California energy crisis of 2001, CEMIRT HVAC crews provided assistance in reducing the energy consumption at Air Force installations. In July 2001, personnel deployed to Prince Sultan Air Base, Saudi Arabia, to complete routine maintenance on generators and complete an airfield lighting vault project.[184]

During Operation Noble Eagle, CEMIRT supported combat air patrols by providing mobile aircraft arresting systems (MAAS) for jet fighters to installations lacking permanent systems. CEMIRT fulfilled a request for one MAAS within 35 days. During that period, CEMIRT overhauled used arresting systems, working 12-hour shifts, 6-days a week.[185]

During OEF, many bases occupied by Air Force personnel were not equipped with aircraft arresting systems. The Air Force drew MAAS assets from war reserves and installed the systems at the overseas bases. CEMIRT was tasked with restocking the reserves with aircraft arresting systems; 14 systems were overhauled by personnel in 20 months while executing ongoing standard assignments.[186] CEMIRT personnel were also vital to maintaining power systems at installations in use throughout OEF and OIF.

CEMIRT personnel installed Supervisory Control and Data Acquisition (SCADA) systems at installations throughout the Air Force. The system comprised hardware and software that enabled Air Force civil engineers to remotely control and monitor equipment across an installation. Operations controlled by a SCADA system included "sewage lift stations, standby generators, water wells, water treatment plants, and electrical substations."[187] In 2005, three bases received SCADA systems that were installed by CEMIRT crews: Hill AFB, Utah; Hickam AFB, Hawaii; and, McGuire AFB, New Jersey.

Growth of Air Force Contract Augmentation Program (AFCAP)

AFCAP remained a vital tool to augment civil engineering support. The AFCAP program manager was located at AFCESA. The AFCAP contractor, RMS, L.C., provided support during its fifth year of the AFCAP contract, which extended through February 2002. For most of the final contract year, AFCAP was used to sustain ongoing operations. Between January and August 2001, 13 task orders were issued through AFCAP. Eight task orders originated from the USAID Office of Foreign Disaster Assistance (OFDA) to procure, ship, and stockpile emergency supplies. The types of supplies procured for OFDA included plastic sheeting, blankets, water bladder kits, tents and tent frames, and rescue boats.[188] OFDA supplies were distributed to respond to an earthquake in India and drought conditions in Afghanistan, as well as for humanitarian relief for Afghanistan refugees in Pakistan.[189] Military task orders secured base operating support for Manta AB, Ecuador; power production professionals for rotations to SWA as part of Operation Southern Watch; and, 16 electrical, civil, and mechanical

A Tyndall CEMIRT technician puts the finishing touches on a refurbished Mobile Aircraft Arresting System.

engineers and construction inspectors who deployed to Prince Sultan Air Base, Saudi Arabia; Ali Al Salem and Al Jaber ABs, Kuwait; and, Al Dhafra AB, United Arab Emirates (UAE).[190]

Between September 11, 2001 and December 2001, 25 task orders were funded through AFCAP and 7 additional requests were issued for bids. Also, 7 additional task orders were issued to procure emergency supplies for OFDA. The largest task was to procure and transport 250,000 blankets to Pakistan for a cost of over $1.5 million. AFCAP was used extensively to provide engineer support for Operations Noble Eagle and Enduring Freedom for humanitarian, logistics support, and force protection efforts. For the first time, AFCAP also was used as a vehicle to support Military Construction (MILCON) projects. At Bolling AFB, Washington, D.C., task orders were issued through AFCAP to conduct a site survey for Hangar 1, renovate Hangar 1 for use as an air operations center, construct open storage for contractor trailers, alter installation entry gates, and construct a perimeter wall between north and south gates. At MacDill AFB, Florida, AFCAP was used to secure a site survey for a mobile structure staging area and to pave a parking lot.

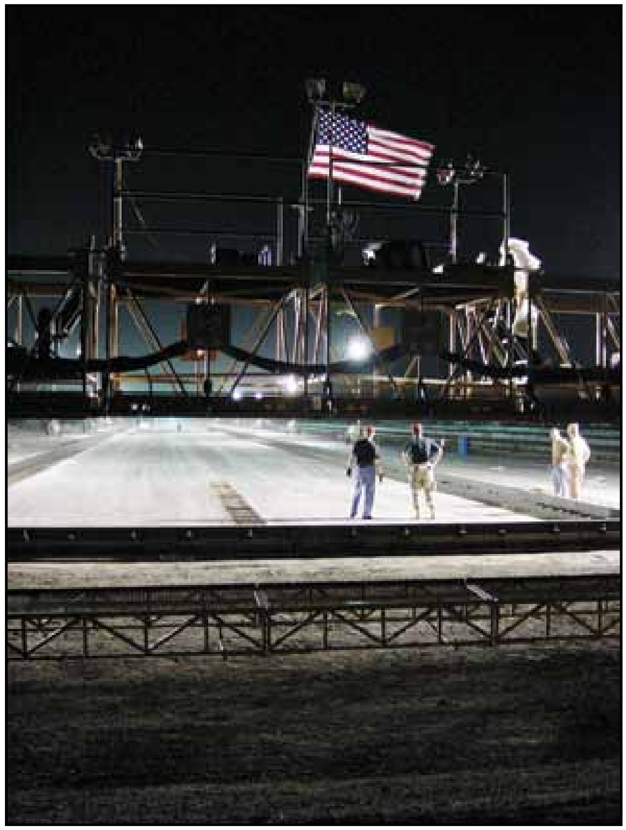
Many AFCAP task orders were issued to support operations in SWA. MILCON construction to build dorms in Kuwait and facilities in Qatar and UAE were tasked through AFCAP. For the first time, RED HORSE squadrons and Prime BEEF teams accessed AFCAP to reach overseas companies to procure and deliver materials to remote or undeveloped areas. Examples of these contracts included short-term leases for heavy equipment, a Geotech Survey for an airfield, procurement of computer support equipment, and designs for hardened aircraft shelters.[191]

During Operation Enduring Freedom, AFCAP was used to provide logistical support, including leasing vehicles and equipment and procuring supplies to support RED HORSE activities. Materials acquired to support RED HORSE operations included concrete, fill material, and asphalt. Local leasing of equipment and local purchase of materials eliminated potential shipment delays from the United States.[192] In addition, the AFCAP contractor provided planning support and arranged transportation of equipment and supplies to the sites.[193]

The AFCAP contractor sent representatives to a forward cell located in the operational theater to facilitate on-site planning and execution of task orders. The cell comprised the AFCAP Program Manager and contracting officer from AFCESA and contractor planning and logistical personnel. In total, 38 task orders were funded through AFCAP between January and December 2001. The total dollar amount for the fifth year of the AFCAP contract was over $49.5 million.[194]

The first AFCAP contract expired February 2002. During 2001, AFCESA personnel prepared a second AFCAP contract slated to begin February 2002. The new contract extended eight years until 2010 with a cap of $400 million.[195] RMS, L.C., won the second AFCAP award in February 2002.[196] RMS, L.C., was an independent subsidiary of Johnson Controls, Inc., and was supported on the second AFCAP contract by eight sub-contractors. The second AFCAP contract was structured so that RMS, L.C., assigned personnel to be on call 24 hours, 7 days per week to plan and provide estimates once a need was identified. Once the individual projects were tasked, the main contractor then mobilized larger groups of personnel to accomplish the task.[197]

Projects assigned to RMS, L.C. under AFCAP during OEF included the construction of two aircraft parking ramps. The parking ramps covered an area equivalent to 18 football fields in size and construction was completed within a compressed schedule.[198] In late 2002, twenty members of the 49th Materiel Maintenance Squadron (MMS) from Holloman AFB, New Mexico, were tasked with the construction of two portable hangars for the B-2 Spirit Bombers at a deployed location. This assignment was completed through the combined efforts of the 49th MMS, CEMIRT, and the AFCAP contractor. CEMIRT linked the hangars to the local power grid. The AFCAP contractor acquired and expedited delivery of construction equipment, as well as purchased and delivered the electrical systems specified by CEMIRT and the 49th MMS. Within ten days of notification to proceed on the project, the AFCAP contractor procured the construction equipment, which included a 7.5-ton crane, and arranged procurement of a specially manufactured stepdown transformer. The equipment was transported to



Members of the 820th RED HORSE Squadron use a paving machine at Al Dhafra acquired through AFCAP.

Dubai International Airport in the UAE, then continued to the deployed location via a Ukrainian IL-76 aircraft. The equipment was in position when the B-2 shelter systems arrived by sea.[199]

AFCAP also was used extensively in the months preceding OIF. AFCAP was used as a vehicle to procure local materials, lease heavy equipment, acquire special equipment, and employ local geotechnical and engineering services. By mid-March 2003, 100 task orders totaling $446 million were issued through AFCAP.[200]

In November 2003, the U.S. Army requested AFCAP support to construct a tent city to house 10,000 soldiers at Camp Taji in Iraq. CMSgt (Ret) Joe Smith deployed with a site survey team to assess the site requirements in order to estimate the cost of the project. He returned to Camp Taji as the interim site manager. He held that position for two months until the assignment of a full-time site manager. He returned to Iraq a third time to support the U.S. Army Corps of Engineers in the construction of a 20-megawatt power plant and distribution system at Camp Victory, Iraq.[201]

Many projects supported by the AFCAP contractor comprised maintenance and operations at forward bases and locations. For example, by 2004, 60 civilian contract personnel operated the airfield at Bagram AB, Afghanistan. This task order was the first civilian contract executed in Afghanistan. Civilian contractors served for one year. Contractors operated the airfield control tower at Bagram and directed air traffic at the nearby Kabul airport. AFCAP contractors also maintained the runways, taxiways, airfield lighting, and communications equipment. Every civilian contractor eliminated the four-month rotational deployment of three military personnel.[202]

By 2005, $950 million was expended through AFCAP to support the U.S. military effort in Afghanistan and Iraq. Task orders were issued by the Air Force, the Army, the U.S. Agency for International Development, and the Coalition Provisional Authority in Iraq. Projects included the construction and maintenance of Camp Cooke in Taji, Iraq; air traffic management at six airfields; electrical power support to power fuels systems; water production and distribution systems; and, construction of improvements to Air Force locations in Kirkuk and Balad, Iraq.[203]

AFCAP also was used to support humanitarian relief. Funds were expended through AFCAP to support relief efforts in the Horn of Africa. In the United States, AFCAP was used as a vehicle for relief efforts following Hurricanes Katrina and Rita.[204]

In 2005, the contracting capacity of AFCAP II was reached and requests for bids to undertake AFCAP III were circulated. The bidding process for AFCAP III was managed by the Air Force Program Executive Officer for Combat and Mission Support in Washington, D.C. The monetary ceiling for AFCAP III was established at $10 billion. The solicitation began in February 2005 and was completed in September 2005.[205] The 10-year AFCAP III contract was awarded on November 8, 2005 to six firms. "The decision to go with more than one contractor helps provide flexibility in our planning and helps mitigate the risk of a single contractor possibly being overwhelmed by a large number of task orders," said Wayland Patterson, the AFCAP program manager at AFCESA. For AFCAP III, contract management was divided based on the nature of the task orders between AFCESA, Tyndall AFB, Florida, and the Air Force Services Agency, San Antonio, Texas.[206]

By 2007, AFCAP had been in existence for ten years. Wayland Patterson reflected on the value of AFCAP to the Air Force when he wrote, "AFCAP was conceived as a means to leverage capabilities from the commercial sector and provide civil engineer and Services personnel with a means to do 'more with less.' Ten years later and on its third contract, the program continues to be a significant force multiplier, not only for the Air Force, but for other government agencies as well."[207] While AFCAP contractors were prohibited from completing initial beddown for Air Force operations or participating in combat, AFCAP contractors had provided vital support at nearly all Air Force forward locations. It was estimated that, by 2004-2005, 75 percent of the AFCAP task orders were for sustaining services, such as electrical production support, air traffic management, and maintenance of infrastructure. Patterson reported that 518 task orders were issued through AFCAP between 1997 and 2007 for a total of $1.62 billion. In 2007, 35 task orders were underway in seven countries for a total amount of $149 million. AFCAP had been used by many agencies in addition to the Air Force, including USAID, OFDA, U.S. Immigration and Naturalization Service, the U.S. State Department, U.S. Department of Justice, the Federal Emergency Management Agency, the National Aeronautics and Space Administration, Homeland Security, and the U.S. International Board of Broadcasters.[208]

Air Force Center for Environmental Excellence (AFCEE)

AFCEE continued to serve as the center for expertise in environmental issues and housing privatization during the first decade of the twenty-first century. In 2001, AFCEE celebrated 10 years of service to the Air Force. That same year, Mr. Gary M. Erickson, AFCEE Director from 1996 until 2003, was awarded a Meritorious Executive award, the highest award for SES. The award was presented by President George W. Bush for sustained accomplishments and outstanding work ethic. Erickson was prompt to pass on the credit to his team. "They're the ones who did the hard work and made it all possible. It's a double enjoyment for me personally to receive the award and also be part of a team that produces a recognition like this."[209]

In August 2003, Mr. Paul A. Parker was selected to the ranks of the Senior Executive Service and appointed as the AFCEE Director, coming from his position as the Deputy Civil Engineer, Headquarters, Air Education and Training Command. Parker began a reorganization to focus AFCEE on the customer and to serve better the Air Force. The organization was reconfigured into the following directorates: Technical, Housing, Base Conversion, Major Command & Installation Support-CONUS (IC and IS), and Major Command & Installation Support-OCONUS (IW). Commands and installations were assigned to a single directorate for assistance with projects and programs. The IW Directorate supported PACAF, USAFE, and Defense units providing Air Force-mission support. The IS Directorate supported AFMC, AFSOC, AETC and Air Force Reserve commands, as well as the ANG and Massachusetts Military Reservation. The IC Directorate assisted Air Mobility, Air Combat, and Air

Force Space commands along with the 11th Wing at Bolling AFB, Washington, D.C., and USAFA in Colorado.[210] By 2007, the IS and IC Directorates were merged into a single Major Command & Installation Support-CONUS Directorate (IC), under which specific offices worked with designated major commands.[211]

In 2004, the Housing Directorate replaced the Design and Construction Directorate. Under this directorate were MILCON programs and housing privatization. AFCEE accomplished more housing work than any other office in DoD. The Base Conversion Directorate provided services for bases that were closed or realigned through BRAC. The Technical Directorate was the designated center of expertise for environmental services and design management. Subject matter experts formed the backbone of the directorate's technical and scientific expertise.[212] During 2004-2005, the number of divisions within the Technical Directorate was reduced from five to four.[213] AFCEE's Contracting, Legal, Mission Support, and Operations and Development Directorates and the Regional Environmental Offices remained unchanged.[214] The 2004 reorganization expanded AFCEE's focus. As General Fox, The Civil Engineer, said, "We've evolved the AFCEE structure over the years. In the beginning we concentrated on the environmental staff. Today, AFCEE has a multi-service engineering capability."[215]

AFCEE's Role in Iraqi Reconstruction

One new area of activity for AFCEE was the reconstruction of Iraq through the Worldwide Environmental Restoration and Construction (WERC) contract. WERC was the fifth in a series of AFCEE contracting vehicles that began in the 1990s. The immediate predecessor to WERC was the Environmental Remediation and Construction Contract. It had a $750 million cap, which was expended within three years of the start of the contract.[216] WERC was an indefinite delivery/indefinite quantity contract awarded by AFCEE on December 1, 2003. WERC had a ceiling of $4 billion with the potential to increase to $10 billion and was awarded to 27 U.S. firms comprising 15 small and 12 large businesses.[217]

WERC was beginning to function at the time that the U.S.-led Coalition Provisional Authority (CPA) was set up to administer Iraq. The U.S. Congress had authorized $18 billion to rebuild Iraqi infrastructure. The CPA needed a funding mechanism to begin immediate reconstruction efforts until a contracting structure was in place.[218] On December 7, 2003, the CPA Administrator in Iraq, L. Paul Bremer III formally requested use of AFCEE's WERC as the contracting vehicle to fund rebuilding military installations in Iraq. Draft requests for proposals for construction projects in Iraq were circulated to WERC contractors on December 19, 2003; 20 contractors expressed interest. Formal approval for AFCEE involvement was granted by Gen. John J. Jumper, Air Force Chief of Staff, on January 14, 2004. In December 2003, Sharon Money of AFCEE's Contracting Directorate was designated as the primary contracting officer for Iraqi projects.[219] On January 9, 2004, final requests for proposals were issued for competitive bids to 22 WERC contractors. One week later, AFCEE received proposals from 12 contractors. Days later, AFCEE awarded four task orders under WERC and mobilized contractors.[220] By February 2004, Gary Bergman and Dan Turek arrived in Iraq to serve as the first on-the-ground AFCEE project managers/contracting officer representatives. The project managers were responsible for monitoring cost, schedule, and quality.

By summer 2004, AFCEE had obligated $600 million through WERC for restoration projects at four Iraqi military bases, including Al Kasik, Taji, and An Numinayah army bases, and Um Qasr naval base. The initial four projects had tight time frames for project completion. The deadline to complete the $25 million construction project at Taji army base was March 2004. Other projects were planned for completion by mid-April and May 2004.[221] Eighty percent of the work contracted through WERC was for rebuilding military installations, including eight major military facilities, some for the Iraqi army and some for the Iraqi air force.[222] Other major military projects included renovating the Iraqi Ministry of Defense building and the Rastamiyah Military Academy, and upgrading military bases in Kirkuk and Ali.[223] Lt. Gen. David L. Petraeus expressed his appreciation for AFCEE's work in an September 18, 2004 e-mail to Lt. Gen. Donald L. Wetekam, Air Force Director of Installations and Logistics,

> First, I want to thank you for the superb support that you, Maj. Gen. Fox, and the team from AFCEE have provided for the reconstruction programs underway in Iraq…. The AFCEE team, which, as you know, came into Iraq to execute work early in the reconstruction process so that we could generate Iraqi Armed Forces as quickly as possible, has contributed significantly to our ability to establish a new Iraqi Army. Without AFCEE intervention at a critical time, we would not have been able to generate the forces as soon as we have. AFCEE's role in this endeavor is a success story.[224]

As the reconstruction effort in Iraq evolved, WERC contractors worked to complete civilian projects. These projects included the renovation or reconstruction of two water-pumping stations and installation of more than 12 miles of water distribution line, three bridges, hundreds of schools, eight medical clinics, Iraqi government buildings, and infrastructure. In all, the renovation or reconstruction of 645 buildings was completed, with an additional 1,173 building projects underway in 2005.[225] Added benefits of the reconstruction effort were to give Iraqi citizens jobs and construction training and to support the rebuilding of Iraqi businesses.[226]

To complete this number of projects, AFCEE used the innovative cost-plus, performance-based construction business model. Under the performance-based construction business model, AFCEE defined the end result of the project and let the contractors present the plans on how to achieve the desired end state. The conceptual plans were approved by the project reviewers and clients and then the contractor produced the implementation work plan to accomplish the project. Once the implementation work plan was approved, the contractor began work.[227] While in Iraq, AFCEE personnel initially worked closely with the U.S. Army Corps of Engineers, who provided quality assurance.[228] By 2005,

Iraqis complete trenching for perimeter lighting on a project completed under AFCEE's management.

AFCEE personnel and contractors provided Title II quality assurance.[229] This method of contracting increased flexibility and rapid response to customer requirements.[230]

By summer 2004, other funding vehicles were available through the Department of State Iraq Project and Contracting Office.[231] Although AFCEE continued to work with the Project and Contracting Office, by the end of 2004 AFCEE's major customer using WERC was the Multi-National Security Transition Command-Iraq.[232] AFCEE established a small office in Iraq which was supported by many individuals at AFCEE headquarters, San Antonio, to keep overhead costs low and reduce the risk to people stationed in Iraq. In 2005, AFCEE managed $1.5 billion of restoration work in Iraq.[233] One project beginning in spring 2006 and completed November 2007 required AFCEE contractors to install 43 wells to provide water to Iraqi installations.[234] In 2007, AFCEE Director Paul Parker summed up the work that AFCEE had facilitated in Iraq, "as I look back at the last three years, I see that the center has managed construction of some 80 military bases, 360 police stations, 469 schools, and 179 miles of pipeline in that war-torn country, at a cost of about $3.5 billion."[235] Parker was also proud of AFCEE's efforts working through WERC contracts to employ and to train Iraqi nationals in construction and to support Iraqi construction firms. By 2005, Parker felt that Iraqi construction companies were capable of executing multi-million contracts as prime contractors without AFCEE oversight. "As far as Iraq reconstruction is concerned, a job well done means working ourselves out of a job, and we have done just that," Paul Parker wrote.[236]

AFCEE employees who traveled to Iraq between 2004 and 2007 numbered 22 civilians and 13 military staff, but many others at Headquarters, AFCEE were involved to ensure that contracting was successful.[237] The statistics for work completed between 2004 and 2009 were truly impressive: 585 projects worth $4.8 billion that encompassed 4,681 facilities totaling over 80 million square feet of rebuilding. These facilities included 34 brigades and 115 battalion garrisons, 469 schools, 11 medical clinics, the Ministry of Defense headquarters, 3 repaired and expanded airports, 15 border forts and expeditionary camps, 264 police stations, and 1 prison.[238] Other aspects of the Iraqi rebuilding program included labor training for Iraqi construction workers, designers, engineers, and contractors; application of advanced procurement techniques for contracts; and, implementation of a quality assurance

Iraqis work to complete an enlisted barracks at an Iraqi military base.

program. AFCEE's program managers collaborated with managers from other U.S. Armed Services and Iraqis to compile building construction standards for the Iraqi program.[239]

In February 2006, the Combined Security Transition Command-Afghanistan requested that AFCEE use WERC to assist in rebuilding Afghanistan. The command's mission was to train and develop Afghan National Security forces. The types of projects funded through WERC contracts were barracks, and operational, maintenance, and training facilities. Between 2006 and 2009, AFCEE had awarded 47 contracts in Afghanistan valued at $560 million.[240] By 2007, AFCEE extended its work to other countries in Southwest and Central Asia, including Kuwait, Qatar, Oman, Saudi Arabia, UAE, and Kyrgyzstan.[241]

In addition to WERC, AFCEE managed two other contracting vehicles, which were established in 2003. One was the Environmental, Construction and Operations & Services (ECOS) program through which construction, repair and demolition projects were completed by seven small businesses. Major commands allocated funds through ECOS to contract with small businesses to perform CONUS projects related to force protection, homeland security, environmental compliance, and conservation and restoration projects.[242]

The second contract vehicle was Design Build Plus 2003, which was used for family housing and commercial and institutional construction projects worldwide. The funding cap was $6 billion. The contract had nine full and open contracts and six small business set-asides. AFCEE contract managers were proud that $203 million or 22 percent of AFCEE's total contract awards in CONUS for FY04 were awarded to small businesses.[243]

In 2006, AFCEE announced the establishment of another contracting vehicle called Heavy Engineering Repair and Construction (HERC). HERC was designed for worldwide construction support, including reconstruction efforts in Afghanistan and Iraq. HERC had an initial cap of $6 billion, with the potential to increase to $15 billion over the five-year span of the contract, plus three, one-year extensions. The ID/IQ contract was awarded to 20 firms, 5 of which were small, disadvantaged businesses. The contract was used for design and construction of new facilities, remodeling and upgrading existing infrastructure and facilities, demolition, and emergency response work. Contracting options included turnkey, design-build, design-build-plus, and design-bid-build projects.[244] Competition requirements for HERC were the most stringent ever for an AFCEE contract. Prerequisite requirements included ability to work in austere, remote, and hostile environments worldwide and $50 million bonding per project was required.[245]

Housing Programs

During the first decade of the twenty-first century, the Air Force's military family housing construction and housing privatization programs continued to earn plaudits from DoD. General Robbins established "Housing Excellence" as one of Civil Engineering's core competencies in 2000. The Air Force based its housing program on the 2004 Family Housing Master Plan developed by a team led by Col. Emmitt Smith, Chief of the Housing Division, Office of The Civil Engineer. The plan was a corporate, requirements-based investment strategy that integrated and prioritized traditional construction and operations and maintenance funding with private sector financing within a single roadmap to revitalize, divest through privatization, or demolish most inadequate CONUS family housing by 2007 and eliminate inadequate housing overseas by 2009. This was in line with DoD's Strategic Planning.[246]

AFCEE played an increasing role in the oversight of MILCON family housing construction funds. In FY04, AFCEE contracted for the construction of more than $193 million for military family housing, and directly managed 40 percent of the housing construction contracts, with the remaining units constructed by the Corps of Engineers or Naval Facilities Engineering Command. AFCEE also managed design projects for the construction of 3,000 additional houses at 11 bases in 5 major commands.[247]

During 2006, AFCEE began oversight of a major family housing construction project at Keesler AFB, Mississippi. The military family housing at Keesler AFB had been devastated by Hurricane Katrina in August 2005. While 600 houses were repaired at Keesler AFB, another 800 houses were demolished. AFCEE completed the design work to construct 1,076 new houses at the base. The new house designs incorporated energy saving features including extra insulation, efficient windows and doors, and energy efficient lighting and appliances. The military housing construction project at Keesler AFB became the largest Air Force housing project. The total cost came to $287 million for the construction of 1,076 new houses. The project was planned in five phases and anticipated to be completed in 43 months.[248] The first houses were completed in 2008 and the entire project was completed in 2010.[249]

AFCEE also actively worked to increase the number of Air Force military family housing privatization projects. The purpose behind privatizing military family housing was to improve the housing stock through partnering with private sector companies to provide modern houses, while maximizing Air Force investment dollars. Over the years, it became apparent that MILCON funding could not meet the large-scale demand to eliminate inadequate Air Force family housing units and provide new or up-graded units. Housing privatization offered a way for the Air Force to leverage its investment to provide upgraded housing units at a faster rate and lower costs.[250]

The Air Force privatization program sought to meet the DoD goal of eliminating all inadequate housing by 2007. In 2003, the Air Force had 104,000 MFH units in its inventory; of that number, 40,000 units were deemed inadequate.[251] The Air Force planned to reduce its overall worldwide housing inventory to 86,000 units, 60,000 of which were in CONUS. The Air Force anticipated privatizing 45,500 MFH units by 2009. Under privatization, private developers took ownership of the housing, but the Air Force retained title to the land. The private developer was responsible for maintaining and upgrading the units for 50 years.[252]

After Lackland AFB's housing privatization in 1998, other bases entered into similar contracts. Robins AFB, Georgia, and Dyess AFB, Texas, became the second and third Air Force bases to privatize military family housing in September 2000, followed by Elmendorf AFB, Alaska. The initial efforts at these four bases privatized 2,320 housing units. Housing privatization projects were underway at Patrick AFB, Florida; Kirtland AFB, New Mexico; Dover AFB, Delaware; Wright-Patterson AFB, Ohio; and, Goodfellow AFB, Texas. The initial goal contained in the 2001 Family Housing Master Plan was to privatize 27,000 housing units.[253] By 2005, the construction or renovation of 2,300 houses at the original four bases was complete and occupied by military families. Housing privatization contracts were in place at nine other Air Force bases and the milestone of privatizing 10,000 housing units had been achieved.[254]

By the end of FY06, AFCEE managed $200 million in Federal investment to obtain $2.4 billion in private sector financing to deliver over 17,000 housing units.[255] In total, private housing developers had spent $2.57 billion on housing, while the Air Force spent $210.6 million on the privatization program.[256] In 2007, the Air Force Military Family Housing Privatization Initiative had reached 19 bases and comprised the construction of 13,811 new units and the renovation of 6,969 units.[257] By 2010, AFCEE had privatized 38,000 housing units on 44 bases, approximately 70 percent of the Air Force military family housing inventory.[258] An additional 23 bases were planning housing privatization projects.[259] During 2011, 3,425 housing units on five bases were privatized, including 1,188 family houses at Keesler AFB, Mississippi.[260] The assessment of the Air Force's housing privatization program was that it resulted in savings of $7 billion in construction and maintenance costs.[261]

Design Programs

AFCEE was charged with establishing a Leadership in Energy and Environmental Design (LEED) certification program for Air Force construction programs. LEED was developed by the U.S. Green Building Council to assess architecture in terms of energy efficiency, water conservation, air quality, sustainable construction materials, and site sustainability. AFCEE incorporated LEED concepts into the design of the replacement military family housing at Keesler AFB, Mississippi. In 2008, the first houses completed at Keesler AFB were LEED certified, making the 700-house construction project the largest LEED certified project in the nation and first LEED certified housing at any Air Force base.[262] On July 31, 2007, The Civil Engineer signed the Air Force Sustainable Design and Development Policy establishing goals and responsibilities to fully integrate sustainable building practices in the facility construction program.[263] The goal was to meet LEED Silver Standard in construction of all new facilities.[264]

AFCEE also continued to manage the Air Force Design and Construction Awards. In 2005, sustainable design was added to the competition and the first winner was a consolidated support facility constructed at Edwards AFB, California. By mid-decade, all submissions were completed electronically through an internet website. The kinds of projects that won awards between 2000 and 2005 included a large number of dining halls, conference centers, and non-mission related facilities. In 2006, Maj. Gen. L. Dean Fox requested that more submissions be made for mission-related facilities, such as work places and flight line facilities.[265]

AFCEE's Environmental Programs

AFCEE's environmental programs remained unsurpassed in the Air Force and continued to be its number one priority. Environmental and restoration budgets were $223.5 million in FY03 and $234.4 million in FY04. AFCEE Director Paul Parker's goal for the environmental program was "to see us focus more on implementation of emerging environmental technologies in an effort to clean up the sins of the past faster and cheaper."[266] Some projects completed during 2004 included encapsulating a drainage canal at Homestead AFB, Florida; developing a probe equipped with a sensor to detect chlorinated solvents in the subsurface; constructing a 300-foot iron barrier to protect a pond on Cape Cod, Massachusetts, from phosphorus contamination; using new technology to inspect fuel pipelines; introducing fuel ethanol E85 at gas stations on two bases; replacing aging gas station fuel tanks on bases; and, fielding a GIS system to track trees and other landscaping features on bases.[267]

The Air Force environmental strategic plan was unveiled in summer 2005. The plan transformed the environmental program and shifted the focus of the program toward increasing support for the warfighter. As General Fox wrote, "Compliance with environmental laws and regulation will continue to be important, but we'll improve how our program supports mission operations. Under the new plan, the quality program will concentrate on compliance for mission's sake rather than for compliance's sake; the restoration program will shift from a milestone to a performance-based focus."[268]

One example of the performance-based focus was the establishment of the Air Force's Remedial Process Optimization (RPO) Outreach Office at AFCEE. Established in 2003, the RPO program was an Air Staff initiative under the Air Force Cleanup Program Performance-Based Management Policy. RPO provided a systematic way "to evaluate and improve effectiveness of site remediation so that maximum benefit is achieved for each dollar spent."[269] The ultimate goal of the program was to cut costs required for environmental remediation and monitoring systems. One objective was to quantify true costs for environmental services. Another objective was to focus on the end result of the remediation project, not on the process. The RPO Outreach Office developed a software tool called the Inventory and Optimization Prioritization Software. The data captured by the software gave all participants a complete cost picture of environmental cleanup and the effectiveness of the cleanup efforts over time. This information assisted major commands in prioritizing cleanup sites and allocating funding.[270]

AFCEE also adopted Performance-Based Restoration (PBR) contracting to complete environmental remediation and restoration at Air Force bases. In use by 2005, PBR held the promise to accomplish environmental cleanup more efficiently, quicker, and less expensively. Using PBR, AFCEE defined the results of the project and let the contractor design and implement the process to attain the goals, while giving the government a fixed price. The contracting vehicle also did not require AFCEE to choose only the lowest bidder, but to evaluate a contractor's skills and past performance. PBR was applied at Whiteman AFB, Missouri. Twelve sites were combined into one larger contract package for phase 1, and 10 additional sites were bundled together for phase 2. At one site, the contractor installed an organic biowall to prevent groundwater contamination from spreading. This method cost $100,000 in contrast to the typical treatment of constructing a clay-lined barrier costing $1 million.[271] In 2007, MacDill AFB, Florida, awarded a base-wide, performance-based contract that covered environmental remediation on 21 known contaminated sites and assessments of other suspected locations. Both the remediation and subsequent monitoring of the locations were conducted and analyzed as one holistic system, not by individual locations.[272]

AFCEE worked to update its environmental tracking system. By summer 2004, the Enterprise Environmental Safety and Occupational Health-Management Information System was under development to replace the older Air Force-Environmental Information Management System (AF-EMIS). The AF-EMIS program was adopted to help installations manage their hazardous materials and wastes. The system tracked the use of hazardous materials from purchase to final disposal. The system printed reports required for compliance needs. By 2004, the system was used by 180 installations. The new system was web-based and merged environmental and occupational health issues. By 2004, development of the system was transferred to AFCESA, though AFCEE maintained a help desk to answer questions for AF-EMIS.[273]

Throughout the decade, the three regional environmental offices (REOs) stayed abreast of Federal, state and local environmental regulations and their impacts to the Air Force mission in their respective regions. The offices were located in Atlanta, Georgia for the Eastern Region; Dallas, Texas, for the Central Region; and, San Francisco for the Western Region. Each REO was led by a director and had a staff of ten. REOs also worked with Federal and state entities to advocate for Air Force interests. The REOs also served as DoD's regional environmental coordinators in EPA regions 2, 6, and 10, and as Air Force liaisons for all ten regions. The issues handled by REOs were varied and included clean air initiatives, water quality, natural and cultural resources conservation, encroachments to bases, and sustainability.[274]

AFCEE continued its support for PRO-ACT that fielded environmental questions from the bases and offered free research time. The service developed an extensive library, which included training videos and copies of previous research reports. Information also was distributed through factsheets and an online web publication called CrossTalk.[275] In 2006, PRO-ACT was discontinued. AFCEE launched a new web-based tool in 2011 called Accessible kNowledge for Sustainable Resources. This system provided search capabilities to users to answer environmental questions.[276] By 2005, AFCEE also fielded 15 courses on the DoD-operated Web University.[277]

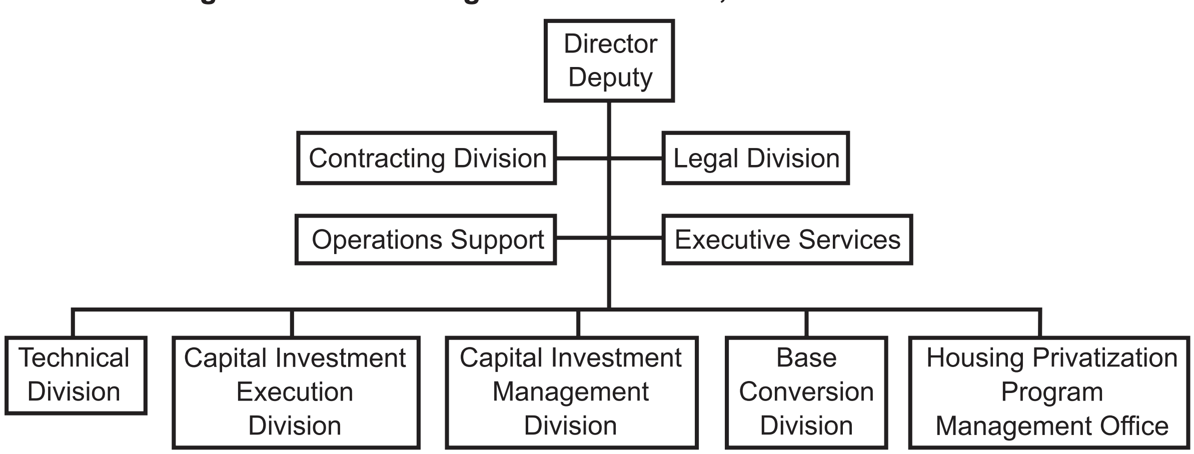
Changes at AFCEE

Transformation affected both the AFCEE organizational structure and how it conducted business. In 2005, AFCEE applied lean management principles to its purchase request process. At AFCEE, the purchase request was a document used to obtain government funds to pay for work done by contractors for AFCEE customers. By reviewing this work flow, participants reduced the typical ten-day process to one-and-a-half days. It also reduced the number of people needed to review and approve the request. Invoice payments was another area at AFCEE examined using lean management principles. Results of the studies often required internal reorganization of offices and divisions.[278] By the end of 2006, lean management practices were applied to the process of preparing task order contract packages. As a result, the process that once took eleven days was shortened to one day.[279]

On June 1, 2007, AFCEE was renamed the Air Force Center for Engineering and the Environment (AFCEE). The new name recognized ACFEE's increased scope of responsibilities for MILCON construction, execution, and management under the *Civil Engineer Transformation Plan*.[280] During 2008, the management for all current and new mission-related MILCON, housing MILCON, and environmental restoration account funds was gradually consolidated at AFCEE from the major commands.[281] Under these expanded duties, AFCEE was designated as the Design Manager/Construction Manager for the entire Air Force MILCON and Housing MILCON programs. It was also authorized to serve as the Design Agent/Construction Agent for up to 15 percent of the Air Force MILCON program and up to 100 percent of the Air Force Housing MILCON program. AFCEE also was responsible for 100 percent of the environmental restoration account funds.[282]

The new responsibilities resulted in internal reorganization. As outlined in the 2007 *Civil Engineer Transformation Plan*, the organizational structure for AFCEE was reconfigured into the following divisions and one office: Technical, Capital Investment Execution, Capital Investment Management, Base Conversion, and Housing Privatization Program Management Office. (Figure 6.7)[283] AFCEE also formed two other program management offices (PMOs): the Environmental Restoration Account PMO and the MILCON PMO. Under the Environmental Restoration Account PMO, AFCEE provided full services from contract award through management of remediation systems. The new office was tasked to develop restoration execution strategies, gather data, and prepare reports for the Air Staff on the overall environmental restoration program. It determined the best methods and practices to complete the goals of the environmental program on individual bases or on a regional basis. By winter 2006, the Environmental Restoration Account PMO was led by interim director Dale Clark.[284] The MILCON

Figure 6.7 AFCEE Organizational Chart, Post-Transformation



Source: USAF, Program Action Directive 07-02, HQ USAF, Implementation of Civil Engineer (CE) Transformation Plan, 19 April 2007, I-5.

PMO was similarly structured to oversee all military and family housing construction. Stephen Escude was appointed interim director.

In response to these expanded duties, AFCEE added more than 130 personnel beginning in FY08.[285] AFCEE also opened additional Regional Management Offices to assist with project management. Regional management offices were located at Ramstein AB, Germany; Hickam AFB, Hawaii; and, at AFCEE Headquarters.[286] By the end of 2007, another office was established at Andrews AFB, Maryland, to oversee Air Force construction in the Washington, D.C. area.[287]

In addition to internal organizational changes, AFCEE adopted a new mission statement. Until 2007, the mission statement read, "To provide Air Force leaders the comprehensive and diverse expertise needed to support the warfighter by protecting, preserving, restoring, developing, and sustaining the nation's environmental and installation resources."[288] By 2008, the mission statement read, "To provide integrated engineering and environmental management, execution and technical services to ensure sustainable installations that optimize Air Force and joint capabilities through sustainable installations."[289] In 2007, AFCEE personnel numbered 45 military and 313 civilian employees. By 2010, AFCEE personnel numbered 48 military and 500 civilians.[290]

AFCEE Director Paul A. Parker summed up the changes of the 2007 transformation,

> The changes will make it possible to speak with a single voice about military construction and environmental restoration, and it will be the Air Force's voice—not AFCEE's. That is a particularly valuable asset in the joint environment that we find ourselves…. This is a valuable asset as we speak with one voice also to our Air Force installations and major commands. We now take on a large facilitative role between installations, major commands, private sector partners and local, state and federal regulators to make sure we are meeting not only the needs of the Air Force but also the needs of the nation.[291]

In November 2007, Mr. Paul Parker took a new position as the Deputy Civil Engineer at Air Staff. Mr. Dennis Firman was promoted to the ranks of the Senior Executive Service, and became the Director of AFCEE, transferring from ACC's Design and Construction Division, where he served as division chief. He brought a wealth of base-level, MAJCOM and FOA experience to AFCEE. He was AFCESA's first executive director, serving from 1994-2000. As AFCEE Director, he helped institutionalize the dramatic changes the organization had experienced as a result of Civil Engineer Transformation and streamlined several business processes. Firman retired from the SES in October 2010.[292] Terry Edwards became AFCEE Director in October 2010.[293] On August 15, 2010, AFCEE was relocated from the former Brooks AFB to Building 171 on the Kelly Annex area of Lackland AFB, Texas.[294] By 2011, AFCEE's organization was reconfigured into the following divisions: Technical, Contingency Construction, Capital Investment Execution, Capital Investment Management, Environmental Restoration, and Housing Privatization.[295]

Air Force Real Property Agency (AFRPA)

On October 16, 2002, the Secretary of the Air Force consolidated the Air Force Base Conversion Agency with the Air Force Real Estate Division to establish the Air Force Real Property Agency (AFRPA). The Air Force Base Conversion Agency was formed in 1991 as the Air Force Base Disposal Agency; the agency was renamed in 1993. AFRPA was designated a field operating agency (FOA) within the Office of the Assistant Secretary of the Air Force of Installations, Environment and Logistics.[296]

At its founding, AFRPA oversaw the disposal of bases under base realignment and closure (BRAC) legislation. Following the 2002 merger, the agency was responsible for real property acquisition, management, and disposal of all Air Force-controlled real property and for all real property transactions on active Air Force bases worldwide.[297] Its responsibilities extended to the execution of enhanced use leases and environmental restoration programs for bases closed under pre-2005 BRAC legislation. Headquartered in Arlington, Virginia, the agency initially was headed by Mr. Albert F. Lowas, Jr, a member of the Senior Executive Service. Ms. Kathryn Halvorson became the Deputy Director in 2003 and was appointed Director in December 2004 when she was promoted to the ranks of the Senior Executive Service. In that year, the agency had a staff of 150 and managed an annual budget of $150 million for operations and environmental programs. In 2005, AFRPA aggressively pursued the transfer of 10,000 acres and 14 bases from Air Force control to local communities or other Federal agencies.[298]

In 2005, AFRPA re-invigorated the enhanced use lease (EUL) program to assist major commands to realize value from under-utilized assets on non-excess land.[299] EULs became practicable after the U.S. Congress adopted amendments to Section 2667 of Title 10, U.S. Code enacted in 2000 in Public Law 106-398. The changes were widely distributed by the Secretary of the Air Force along with instructions for the submission of potential EUL properties to AFRPA for consideration.[300] The legislative amendments made a wider range of options possible in the negotiation of EULs. Lessees paid fair market value for property, either in cash or in-kind. The range of in-kind options was expanded under the amendments to include the construction of new facilities or the in-kind equivalent at another installation. The advantage of EULs was the ability to generate cash to support base operations from under-used real property assets. By May 2001, leases were under review for Brooks City Base in Texas, which had been authorized by special legislation.[301] The aftermath of the September 11, 2001 attacks and resulting heightened base security prevented aggressive pursuit of EULs for several years. Lease potential was revisited after a memorandum dated April 14, 2003 from the Office of the Secretary of the Air Force requested that the civil engineer community explore possible EULs at all Air Force, ANG, and Reserve bases, despite the restraints imposed by installation mission and antiterrorism and force protection requirements.[302] While EULs offered obvious benefits, the program took several years to establish and several more years to implement. By 2007, the first EUL was executed at AFMC's Kirtland AFB, New Mexico, and a second EUL was in progress at Hill AFB, Utah.[303]

In 2007, AFRPA employed more than 200 Federal personnel and contractors. The agency was organized into three offices: Operations, Financial, and Information. The agency's personnel provided expertise in real and personal property, real estate law, environmental restoration and compliance, environmental law, facility maintenance and operations, financial management, human resources, information technology, and public affairs.[304]

Accomplishments during 2007 included a public auction of the Calgary housing units at the former Kelly AFB, Texas; execution of an environmental services cooperative agreement for 62 acres of the former McClellan AFB, California; sale of 40 acres on Point Escanaba, Michigan, to the Hannah Indian Community, which assumed responsibility for all environmental restoration; and, transfer of 39 acres to the St. Louis Port Authority in Missouri for redevelopment. The Port Authority also agreed to accept all responsibility for environmental remediation. AFRPA reported that the transfer to local redevelopment authorities was completed for 17 of the 32 installations closed under pre-2005 BRAC. Four additional transfers were completed in FY07 and included Rickenbacker ANGB, Ohio; Carswell AFB, Texas; Castle AFB, California; and, Homestead ARB, Florida.[305]

In July 2008, the agency relocated to San Antonio, Texas; the move was among the 2005 BRAC recommendations.[306] The agency was collocated with AFCEE, which enhanced AFRPA's effectiveness. AFRPA had an established working relationship with AFCEE. In March 2008, AFRPA and AFCEE awarded a performance-based contract for the former England AFB, Louisiana and Myrtle Beach AFB, South Carolina. Award of this contract was a major milestone towards the disposal of these properties by 2010. AFRPA was proud of their aggressive transfer completion record.[307]

In August, 2008 AFRPA signed an EUL lease agreement to develop the Falcon Hill Aerospace Research Park at Hill AFB, Utah. This EUL was the largest and most ambitious to date. The EUL involved a 550-acre site on the west side of Hill AFB; development included facilities for Air Force personnel, office parks, hotels, restaurants, and shops accessible to the public.[308] By 2008, AFRPA had executed leases for 4 EULs and was processing 32 projects. Four projects were under negotiation, while 4 more were in the project definition and acquisition stage. Twenty projects were under identification. The number of projects had increased as a direct result of the Secretary of the Air Force designating the EUL program as a High Value Initiative and allocating $3 million in seed money.[309]

Another promising avenue for creative utilization of Air Force real estate was the exchange of real property for construction. The Air Force transferred real property in exchange for the construction of Air Force facilities. Land exchange was first used in 2005 by the Air Force Space Command's (AFSPC) Space and Missile Systems Center, which exchanged land for the development of a new Systems Acquisition and Management Support complex at Los Angeles AFB, California. The 560,000 square-foot complex was energy efficient and seismically safe. This exchange required special authorization under the FY01 DoD Authorization Act, Section 2861, passed in 2000. The agreement between the developer and the Air Force was signed by the Assistant Secretary of the Air Force for Installations, Environment and Logistics. The project was managed by the civil engineer of Headquarters, AFSPC.[310] In 2008, proposed projects under consideration by AFRPA for land-development agreements included the exchange of 50 acres at Norwalk Defense Fuel Depot for construction at March ARB, California; the exchange of 144 acres at the Lynn Haven Fuel Depot for construction at Tyndall AFB, Florida; and, the exchange of 72 acres at Buckley Annex, Colorado, property for construction for the Air Force Reserve Command at Wright-Patterson AFB, Ohio.[311]

Mr. Robert Moore became the Director of AFRPA in January 2009, upon his promotion to the Senior Executive Service, and oversaw its reorganization to focus on real property transactions, strategic asset management, BRAC program management, and real property management. The agency employed 171, including secretariat real property legal advisors. The reorganized agency contained six offices and/or divisions: Chief Financial Officer, Chief Information Office, Real Estate Transactions Division, Real Property Management Division, Strategic Asset Utilization Division, and BRAC Program Management Division. The reorganization integrated the Air Force's transformation goals for asset management, enhanced use leasing, and energy. The objective of the reorganization was to make AFRPA the "leading provider of full-spectrum real property portfolio management and transactional services to enable sound decision making by Air Force leadership."[312]

In 2009, the Real Estate Transactions Division processed over 800 real estate transactions, including $19.5 million in real property gifts received during the five previous years. Fisher houses were added at Eglin AFB, Florida; Elmendorf AFB, Alaska; and, Wright-Patterson AFB, Ohio. This division also processed real estate easements, leases and licenses.[313]

The Strategic Asset Utilization Division oversaw the EUL program. During 2009, the Air Force embarked on an aggressive campaign to promote EULs by hosting EUL Industry Days throughout the United States. The Strategic Asset Utilization Division continued work on the EUL at Hill AFB, Utah. Another EUL project was the construction of a wastewater treatment plant on land at Nellis AFB, Nevada, which supplied the base and the local community with wastewater for irrigation and paid for the renovation of a base fitness center.[314]

The BRAC Program Management Division added 8 bases to the 32 former BRAC properties managed by the division. By 2009, 87 percent of land made available through BRAC was transferred to local communities. During 2009, Environmental Protection Agency officials announced the delisting of Griffiss AFB, New York, from the National Priorities List following environmental cleanup efforts. This announcement allowed AFRPA to transfer 4.5 square miles of land to the city of Rome, New York, for development.[315]

In 2010, the Real Estate Transaction Division reported the completion of 400 real property transactions, including real property gifts, real estate easements, leases and licenses, Federal-to-Federal property transfers, and BRAC transactions. Several EULs were underway. At Eglin AFB, Florida, 255 acres were leased to Okaloosa County for the construction of a state-of-the-art water reclamation facility to serve both the base and the surrounding area. The annual payment to Eglin AFB provided funds for base improvements. At Edwards AFB, California, an EUL was under development for a solar energy project, while a waste-to-energy plant was under development at Hill AFB, Utah. In July 2010, the first property was transferred in accordance with 2005 BRAC; the former General Mitchell ARS was transferred to the General Mitchell International Airport in Milwaukee County, Wisconsin.[316] By 2011, AFRPA employed 230 civilians and contractors who provided expertise in real property, environmental cleanup and compliance, financial management, facility operations and maintenance, public affairs, environmental and real estate law, civilian personnel, and information systems.[317]

Air Reserve Component (ARC) and the Total Force

During the first decade of the twenty-first century, ANG and Air Force Reserve personnel were deployed alongside active duty military personnel as total force civil engineer squadrons grew in number. Col. Janice M. Stritzinger, who served as the Civil Engineer for the ANG, provided a description of the structure in 2001, "the ANG provides about 29 percent of the total engineering force in the Air Force. The Reserve has about 17 percent and the active has the remaining 54 percent. About 10 percent of our ANG civil engineer force is comprised of full-time personnel. The remaining 90 percent are drilling Guardsmen who dedicate their weekends and free time to serving their country through augmentation of our total force missions."[318]

In 2000, ANG activated the 254th RED HORSE Flight and the Air Force Reserves activated the 555th RED HORSE Flight. Both were designated under the active duty 554th RED HORSE Squadron, making it the first "total force" civil engineer squadron of the Air Force. In 2002, the 200th/201st Expeditionary RED HORSE Squadron (ERHS) became the first ANG RED HORSE Squadron to support a major wartime operation and perform as a "full" RED HORSE squadron, rather than just augmenting active duty operations or backfilling open positions.[319] At the beginning of OEF, ANG and Air Force Reserve civil engineers were activated to fill positions left vacant by deployed personnel at home bases. The ANG and Air Force Reserve civil engineers integrated into the AEF deployment rotation and were activated as needed as mission requirements expanded. As a result, all civil engineer personnel assets were available for deployment, including Prime BEEF, RED HORSE, active duty, ANG, and Air Force Reserve. ANG and Air Force Reserve teams of EOD personnel, firefighters, and engineering assistants were called upon frequently to supplement stressed active duty career fields. In 2003, Maj. Gen. L. Dean Fox praised the level of integration between active duty civil engineer personnel and ANG and Air Force Reserve civil engineer personnel. General Fox noted, "we couldn't do the job without them. In some areas we find that our Air Reserve Component (ARC) members are a little more experienced than our young active duty people, because they've been around a lot longer and some are previous active duty themselves. What they bring to the fight is experience and know-how, and from their civilian jobs an expertise that is unequaled outside this country."[320]

203d RED HORSE Flight Plane Crash

On March 3, 2001, 3 members of the Florida Army National Guard and 18 RED HORSE engineers from the 203d RED HORSE Flight lost their lives in a plane crash in southern Georgia. The members of the 203d were returning to Virginia from an annual training event at Hurlburt Field, Florida. Their C-23 Sherpa crashed into a farmer's field in a rural area near Unadilla, Georgia. The accident was considered the largest loss during peacetime for the entire Air National Guard. The day following the crash, Secretary of Defense Donald H. Rumsfeld remarked, "Military service involves great danger, in times of peace as well as war, and this accident provides stark proof of that."[321]

Shortly after the crash, the 203d RED HORSE established a fund to create a commemorative site. A 30,000 square-foot memorial was created for the guardsmen at the 203d RED HORSE headquarters at Camp Pendleton, Virginia Beach. A 7,000 pound piece of polished black granite was the focus. The names of the eighteen 203d RED HORSE Flight engineers and the three Florida Army Guardsmen from the 171st Aviation Battalion were etched into the stone. A kneeling RED HORSE statue was placed in front in honor of the RED HORSE engineers. A pathway lined with 22 trees encircled the memorial; 21 trees memorialized those killed in the crash, while one tree memorialized the victims of the September 11, 2001 terrorist attacks.[322]

The memorial was dedicated on March 3, 2002. The 203d RED HORSE continues to commemorate the guardsmen each year. In 2011, on the tenth anniversary of the crash, military and civilians gathered at the memorial to pay tribute. Lt. Col. Pete Garner, commander of the 203d RED HORSE Squadron remarked, "we take time out each year to honor these fallen heroes and what it means to be a citizen Airmen and Soldier…we don't take this commitment lightly because we know there is a price to be paid for the freedoms we enjoy in this great nation."[323]

The Future Total Force played a significant role in Air Force transformation during the first decade of the twenty-first century. Three main advantages were realized through that concept: ARC gained experience with new weapons systems, keeping them up-to-date for future missions; ARC's capability was expanded to efficiently contribute to Air Force manpower; and, ARC was a "cost effective force multiplier" reducing the load on the active duty military.[324]

By 2006, the term *Future Total Force* was removed from the Air Force vocabulary and replaced by *Total Force Integration*. The choice of the word *integration* reflected the continued commitment to incorporating active duty, ANG, and Air Force Reserve personnel into one force. This commitment was not a future objective, but an ongoing reality. The level of Air Force commitment was demonstrated in 2008. In that year, the Air Force announced the 30-year plan for the permanent assignment of new aircraft. ARCs would play a major role in the assignments, serving as "owners or joint users" of the new resources. The announcement marked a major step for the Air Force and for the ARC. Reserve personnel were no longer a force augmenting the active military; they were full members of the Air Force Total Force.[325]

MANAGING THE PERMANENT BASES

Introduction

Maj. Gen. Del Eulberg relied on the resourcefulness of Air Force civil engineers on the bases to achieve transformation. He said,

> Civil Engineers directly support [Air Force] priorities by strengthening our warfighting capabilities; constructing and maintaining facilities that provide quality areas for Airmen and our civilians to work, train, and live in; and reducing costs to free up resources for modernization. This is a challenging time, but we have our most valuable resource – you [the Air Force civil engineers]. I am deeply comforted by the certainty that, every day, 60,000 civil engineers come to work with the intent to do what is right and best for our country. It is this resource that will guarantee our success in our current transformation efforts.[326]

Transformation affected all areas of installation management. All personnel were called upon to review their work processes, eliminate non-productive procedures, and seek improvements in efficiency and effectiveness. Transformation required a major reorganization of the civil engineer squadron (CES) at the base level and the implementation of new initiatives. While many transformation initiatives were developed at higher command level, implementation often fell to installation personnel. Civil engineer personnel at the installation level were encouraged to submit suggestions for improvements through the chain of command and to commissioned transformation leaders.

Major transformation initiatives included "Back to Bases," facilities modernization, asset management, space optimization, GeoBase, airfield obstructions, and major investment in the next generation of information technology. Bases were the subject of several exhaustive studies to collect and validate baseline data on facilities and current software programs. These studies became the foundation to build activity management plans and to conduct energy audits. Aggressive environmental and energy programs continued to be implemented on the bases. Housing privatization continued to be a major program. Other changes to base operations were the result of increased safety and security concerns. The attack of September 11, 2001 had a profound impact upon base level operations. Force protection was improved through the construction of new gates and fences. Force protection guidelines were met through the retrofit of buildings. Firefighting, EOD, and emergency services also evolved through the time period.

As General Eulberg summarized,

> As Air Force civil engineers, we all know our jobs continue to become more difficult and demanding due to budget constraints, a high deployment ops tempo, and the simple fact that the facilities and infrastructure we have to maintain are larger than what the Air Force requires. These and many other important factors, such as energy costs and conservation, Base Realignment and Closure actions, joint basing, new organizational constructs, and changes in information technology systems and requirements, are driving Air Force civil engineers to develop new ways of thinking. We are using this opportunity to transform how we do business across our Civil Engineering mission areas and to institute the industry-proven Asset Management approach; all driven by proven commercial off-the-shelf technology solutions.[327]

Back to Bases Initiative

In spring 2003, Maj. Gen. L. Dean Fox became The Civil Engineer and initiated a renewed emphasis on the individual bases. In his first column in the *Air Force Civil Engineer,* General Fox introduced a main focus of his tenure: Back to the Bases. General Fox challenged all Air Force civil engineer personnel "to look at everything we do across the very broad spectrum of engineering tasks and ensure what we're doing is delivering first-class support to the people and missions at base level."[328] His 'Back to Bases' initiative sought to facilitate the base mission by ensuring that civil engineers were supported by the policies and resources necessary to execute their jobs.[329] General Fox believed that the base was the backbone of the Air Force mission; if a base was successful, then ultimately the Air Force would be successful.[330]

A Back to Bases Task Force was established to identify areas for improvement in the base-level organizations. There was concern among civil engineer senior leaders about the squadrons' ability to support all aspects of their installation missions. The task force was chartered to "visit a representative sample of our bases to identify both "gaps" (areas where the bases need help) and "best practices" in our base-level capabilities, and make recommendations" for the major commands, field operating agencies, and Air Staff.[331]

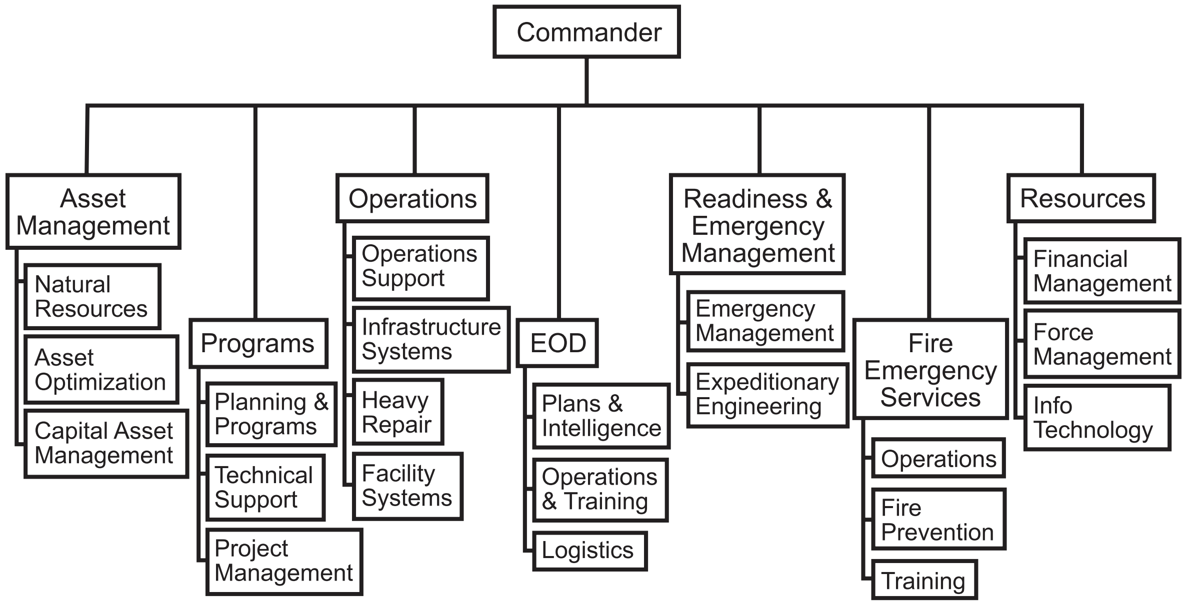
By the end of 2003, the Back to Bases Task Force had completed its field investigation. Major commands and field operating agencies used the findings to address problems and areas of concern at the installations. Fifty-seven categories for base improvement were identified. Action items included: revising the format and content of the Base General Plans, updating as-built drawings, and updating real property records.[332] Following the Annual Programmer's Conference, General Fox charged personnel from the Air Staff Divisions, AFCESA, and AFCEE to address the concerns identified by the task force. The team generated and applied solutions with the assistance of major commands.[333] In 2005, the Reach-Back Center was established at AFCESA to answer questions and provide additional assistance to base personnel.[334]

Headquarters PACAF followed General Fox's lead and implemented its own program to evaluate the bases in its command and to generate solutions for problem areas. Headquarters, PACAF utilized three programs in this process: the Infrastructure Assessment team, the Civil Engineer Management Team (CEMAT), and the Vendor Training Program. The Infrastructure Assessment team was focused on key mission-critical infrastructure, such as airfield pavements and lighting, aircraft fuel storage, electrical power systems, and water and wastewater systems. The team assessed conditions at the bases throughout the command to validate project requirements and to allocate funds to renovate the most pressing needs."[335] The CEMAT, established in 2000, was similar in intent and purpose to its predecessor Civil Engineering and Services Management Evaluation Team from the 1980s. The team visited each base and worked primarily with the operations and engineering flights. The purpose of the visits was to work with the flights to improve the efficiency and effectiveness of work processes and procedures. The third program was the Vendor Training Program where commercial vendors provided on-base training in selected equipment. On-base vendor training saved time and money for the Air Force since PACAF bases were widely dispersed.[336] In 2003, ACC embraced CEMAT for their command based on the success of PACAF's CEMAT. CEMAT for ACC visited each installation twice a year to review management practices and to recommend solutions.[337]

Transforming the Base Civil Engineer Squadron (CES)

Transformation of the base civil engineer squadrons (CES) was one of the five initiatives contained in the April 2007 *Civil Engineer Transformation Plan*. The base CES structure in place since 1993 was organized into eight flights: Housing, Engineering, Operations, Environmental, EOD, Readiness, Fire Protection, and Resources. The implementation of a radical new CES organizational structure went

Figure 6.8 Post-Transformation Base Civil Engineer Squadron Organization



Source: USAF, Program Action Directive 07-02, HQ USAF, Implementation of Civil Engineer (CE) Transformation Plan, 19 April 2007, V-5.

into effect on October 1, 2007. The new CES structure contained seven flights: Asset Management, Programs, Operations, EOD, Readiness and Emergency Management, Fire Emergency Services, and Resources (Figure 6.8).[338] A CES reorganization implementation plan was issued in November 2007 detailing the reorganization of the flights; the plan also included mission statements, objectives, and duty changes for each flight. Completion of this transformation initiative was mandated at all bases by October 2008.[339]

The goal of the reorganization was summarized by General Eulberg, "The squadron reorganization will create efficiencies by changing, realigning, and, most importantly, standardizing our business processes across the entire enterprise. Looking closely at processes and workflows, then combining, streamlining, or eliminating them where it makes sense to do so, will garner efficiencies, enabling us to balance our workload with the right resources."[340] The new organizational structure assured the identical organization of all active duty civil engineer squadrons at Air Force bases, but did not extend to bases operated by contractors, most efficient government organizations, or the ARC. The implementation plan required adherence down to the flight and element structure.[341] General Eulberg noted that identical base organizations were the basis for standardizing working processes and dispelling the notion that bases were unique from one another.[342] Restructuring also simplified the transfer of information and facilitated communication among bases and from base to major command.[343]

The reorganization accomplished more than renaming the CES flights. The asset management approach was adapted to real property and facilities management. The new Asset Management Flight had three elements: Natural Resources Management, Asset Optimization, and Capital Asset Management. The new flight structure combined elements from environmental, housing, real property, and base-level community planning. The Asset Optimization element functioned as a hub "for aligning the squadron's strategic direction with the wing and higher headquarters, consolidating and reporting key performance indicators, and ensuring processes align with standardized Air Force playbooks."[344]

Facilities Management Strategies

Asset Management

Asset management marked a major change in Air Force civil engineering culture. Air Force civil engineering defined asset management as "systematic and integrated practices through which the Air Force optimally manages its natural and built assets and the associated performances, risks and expenditures over the life cycle to a level of service to support missions and organizational goals."[345] Although Air Force civil engineering historically had practiced aspects of asset management, the integration of the holistic approach required a shift in the civil engineering management paradigm. This change promised greater management efficiencies, including "an accurate, transparent built- and natural-asset inventory for each Air Force installation; common levels of service and standardized civil engineering processes across the Air Force; a capability to analyze and communicate best business cases based on risk, cost, and benefits; better visibility and management of space to shrink our footprint; predictive maintenance capability across infrastructure life cycles; use of the Air Force's size to obtain best price and reduce costs; and, a way to credibly advocate and allocate resources."[346]

Activity Management Plans

Activity management was a disciplined, standardized process as well as an integrated practice (i.e., planning, resources, processes, systems) through which an organization qualitatively and quantitatively balanced benefits, costs, and risk to justify the best business case for managing its built and natural assets (for example: land, buildings, structures, energy, permits and credits, mineral rights, air space, etc.). Air Force civil engineers began using the activity management process to integrate the requirements necessary to deliver installation support services required for successful mission completion, to provide the capability to advocate for resources, and support the allocation of those resources to provide, operate, maintain, and protect installations and their infrastructure at the lowest life-cycle cost. Activity management allowed civil engineers to identify and prioritize investment needs to meet the Air Force's defined levels of service.[347]

Activity Management Plans (AMPs) were instituted at each Air Force installation to support planning, programming, and prioritizing projects; identifying base needs; and, quantifying risks of deferred maintenance. A secondary purpose of the AMP was to codify and standardize information collected for civil engineering activities.[348] Finally, the AMP standardized the management of assets based on life-cycle analysis.[349] An AMP was prepared for a single location and contained all information relating to the activity. It allowed for a detailed data analysis and for planning, executing, and assessing investment projects necessary to sustainably deliver levels of service cost-effectively. It also included process steps, mechanisms for action plan development, process improvement results monitoring and implementation for lessons learned.[350]

The Air Force AMPs were designed to replace multiple facility planning documents, such as the family housing and dormitory master plans, base-to-command plans, and the five-year infrastructure plans. The AMPs offered the advantages of streamlined processes and leadership access to data on all levels to focus monetary resources and to support long-range planning decisions.[351] In January 2009, AMP training began for Air Force civil engineers. Between February and September 2009, teams visited 88 active duty installations to prepare AMPs in five areas: facilities, utilities, transportation, waste management, and natural infrastructure. By mid-September 2009, the first base comprehensive AMPs (BCAMPs) were prepared and all BCAMPs were completed by January 2010. Planning to incorporate the BCAMPS into major command AMPs (MCAMPs) was initiated. MCAMPs were begun in November 2009 and completed in September 2010.[352]

By 2010, the AMPs were demonstrating their usefulness. Decisions for the FY12 POM were based on the AMP findings, particularly in prioritizing and justifying requirements for fixing infrastructure. General Byers wrote,

> For the first time, we can "roll up" all of our requirements within specific activities, such as airfield pavements, across bases and MAJCOMs, and produce an integrated priority list across the Air Force. The AMPs are helping drive a "worst first" effort that targets assets with the greatest need first for better allocation of our limited funds, putting our dollars where we need them most. Your efforts in the AMP builds are helping us show senior leadership what impact the years of taking risk in infrastructure and reduced funding has had on our installations.[353]

<u>Space Utilization and Optimization</u>

"Optimizing Air Force Space" was Air Force Civil Engineer Transformation Initiative M-6. In December 2007, the M-6 team was commissioned to define new standards and processes for space management Air Force wide. Space optimization was defined as "managing space more effectively and efficiently to achieve cost savings."[354] Throughout 2008, the team investigated alternative standards for administrative space allocation and crafted recommendations for new standards, processes, and key performance indicators. Recommendations included adopting new standards for measuring interior space. Previous interior measurements had only captured the square footage of a building. The new approach measured interior space by room. The adoption of General Services Administration (GSA) standards to plan for administrative personnel needs also was recommended. The team tested a commercial software application for facility management that depicted interior space allocation and use, including vacant space. The software linked spatial data to utility costs, energy use, and janitorial expenses.[355]

The purpose of the space utilization investigations was to identify ways to manage space better and to reduce facilities footprints, thereby reducing future Air Force investment. "In pursuing improvements to the physical plant, we must think holistically; we must look at the sustainability of an entire base, beyond the base's footprint, to ensure we make the best possible decisions for the long term…Rather than simply validating the need for space, then programming a MILCON, we scrutinize consolidation possibilities and actively encourage demolition or downsizing in association with new construction," General Byers wrote.[356]

Advances in IT applications for civil engineer business processes provided tools to track interior spatial use by organization with an eye towards consolidating spatial needs within sustainable facilities and demolishing inefficient excess facilities. In 2009, a Space Optimization Playbook was issued and the space optimization tool known as the S-File was available. The S-File provided a means of capturing the use of facility space across the Air Force.[357] The playbook was updated in 2010 and issued through the civil engineer portal in August 2010.[358]

In 2010, General Byers announced that the Air Force had adopted the 200 square feet per person utilization standard for administrative space. This standard reflected GSA's space utilization for personnel. This new standard was designed to curb organizational sprawl and to counter the mindset that "new mission/realignment equals new building," thus reducing MILCON costs.[359]

General Byers summarized the Air Force problem:

> Both age and size contribute heavily to the sustainability of each facility. At 32.5 years, the average age of an Air Force facility mirrors the industry average. However, when facility size is compared, the Air Force averages only 12,000 square feet to industry's 250,000 square feet per facility. The Air Force also manages 20 times the number of

> facilities than does industry. This drives higher sustainment costs, since each facility has its own HVAC, plumbing, roofs, and other features. By consolidating personnel to newer and larger buildings, while divesting older and smaller facilities, the Air Force can both reduce operating costs and improve the average condition of its facilities.[360]

Facilities Demolition

General Eulberg instituted a new goal to reduce the footprint of facilities through demolition. General Eulberg maintained that BRAC 2005 had not reduced Air Force facilities and infrastructure sufficiently. It was up to the Air Force civil engineers to "shrink from within." "Develop an Air Force Demolition Policy" was Air Force Civil Engineer Transformation Initiative M-5. In March 2009, General Eulberg signed the Air Force Demolition Policy that presented a comprehensive strategy for the demolition of surplus and inefficient facilities. A team was commissioned to develop "an effective approach to identify and prioritize demolition requirements, advocate for and acquire funding, demolish obsolete and excess facilities, and track progress towards meeting footprint reduction goals." The team also developed a playbook to explain and guide the demolition process.[361]

The demolition policy established demolition targets for each major command. The overall goal was to reduce facilities by 86 million square feet from the 431 million square feet recorded in baseline data from September 30, 2006. The target for attaining this goal was 2020.[362] The DoD goal established for FY08-FY13 required the Air Force to dispose of 15 million square feet and $868 million of plant replacement value of non-facility assets.[363]

Funds for facility demolition decreased during the mid-decade pending BRAC recommendations. In FY07, General Eulberg pushed facilities demolition and approximately 3 million square feet were demolished in both FY07 and FY08. In FY09, the Air Force received $108 million through the AFSO21 program for demolition.[364] Upon assuming the Office of The Civil Engineer, General Byers continued the demolition program and linked it to optimizing space utilization. Between 2006 and 2010, the Air Force disposed of 23 million square feet of buildings and infrastructure.[365]

Fire Emergency Services

At CONUS Air Force installations, firefighters continued to provide round-the-clock fire protection based on risk management assessments. As part of the 2007 *Civil Engineer Transformation Plan*, a review of the firefighting personnel requirements revealed that high numbers of firefighters remained on continuous call to respond to emergencies. Applying acceptable risk analysis identified that high risk periods at Air Force bases typically occurred during normal working hours, while low risk times were at night. Base-level statistics further established the probability of an aircraft fire at once every 611 days and a building fire at once every 108 days. Responses to calls for medical assistance were more frequent and occurred approximately once every 2.7 days. Medical assistance calls, though frequent, required fewer resources. Based on this analysis, a proposal to adjust the level of service during low risk periods was advanced.

In addition, the adoption of new technologies helped reduce fire risk factors in daily operations. The introduction of JP-8 jet fuel resulted in fewer aircraft fires. The incorporation of ultra-high pressure technology on firefighting vehicles extended and maximized the efficiency of dispersal of firefighting agent.

During summer 2006, fire chiefs and civil engineers met and evaluated various staffing options. After discussions, the fire chiefs agreed to reduce the number of military and civilian firefighters by 901 positions or 14 percent. A new firefighting concept of operations was published in June 2007. This plan transitioned Air Force firefighting capability from risk avoidance to risk management. Under this plan, firefighters emphasized, "fire prevention, early intervention at fires, cross-manning of selected vehicles, continued leveraging of technology, and the allocation of resources based on accepted risk management practices." This redefined capability enabled the Air Force to reduce Fire Emergency Services by 901 authorizations across the service.[366]

Firefighters remained busy despite the reductions. For example, between October 2006 and March 2007, firefighters saved 41 lives on Air Force installations and extinguished fires in 6 military family housing units.[367] In September 2006, firefighters at Vandenberg AFB, California, assisted in containing a wild fire. The California fire was the fifth largest wildfire in the state's history and involved 162,700 acres. The 18-member Vandenberg Hot Shots crew spent a month on the fire line.[368]

In response to the 9/11 emergency, Congress gave DoD a way to contract fire protection services during an emergency or contingency situation. At Dyess AFB, Texas, approximately 80 percent (55 military personnel) of the fire department deployed, leaving only 15 personnel in the station to provide coverage for the B-1 and C-130 missions. Dyess personnel were able to provide adequate manning by hiring temporary firefighters (Abilene, Texas, firefighters) and paying civilians overtime for five months. This incident encouraged the Air Force to seek legislative relief to contract emergency response capabilities on a limited basis and only up to one year.[369]

Training continued to evolve to equip fire protection personnel with the latest technology and data on fire hazards. To conserve funds, PACAF established a three-week rescue training course for firefighters in 2008 and opened a firefighting training site at Kadena AB, Japan. The Rescue One course typically was conducted at Goodfellow AFB, Texas, at a cost of approximately $15,000 per firefighter.[370] A new multi-media firefighting training program was developed by AFSPC, ACC, and AFCESA for firefighting personnel in 2010. The Munitions Firefighting Multi-Media Training Program sought to expand the knowledge and skill base of firefighters in ICBM and spacelift operations.[371]

Firefighters also continued to strengthen capabilities in a combined environment, working with other countries to acquire new skills as well as share knowledge. For example, in 2001, Air Force firefighters from Rhein-Main Air Base, Germany trained with firefighters from Frankfurt International Airport at the German Federal Armed Forces base in Mainz, Germany. The three-day training event

A new P-34 Rapid Intervention Vehicle uses its high pressure capability at the Silver Flag fire pit.

included a total of 20 firefighters. The primary task was to perform and enhance search and rescue operations around a ruinous three-story concrete building. The building was created to duplicate a war scenario for training purposes. Teams created medical facilities and shelters, secured the building for safety, and removed debris. During the next phase of training, a gas explosion was simulated at the building. Personnel rescued "victims" and practiced with breathing devices and thermal imaging.[372]

The Air Force Research Laboratory's (AFRL) Fire Research Group continued to experiment with new technology and equipment to support firefighters working in unique situations as part of expeditionary forces. The Combined Agent Fire Fighting System was developed as a light and air transportable alternative to the heavier P-19 vehicle. It was a dual-agent system for combating hydrocarbon fuel fires. The AFRL also began development of an improved suspension system to decrease the potential for rollovers.[373] The first P-34 Rapid Intervention Vehicle came off the production line in September 2011. It was the first Air Force firefighting vehicle to use new ultra high pressure technology. Developed and tested by AFRL, it discharged a mixture of water and firefighting foam at 1,359 psi, making it 3 to 3.5 times more effective than conventional firefighting vehicles.[374]

The firefighter award for heroism was renamed in 2010 to honor the Air Force's most decorated firefighter. Robert A. McAllister served 28 years active duty followed by 22 years in the civilian sector. While in the Air Force, SMSgt. McAllister received two Distinguished Flying Crosses, two Bronze Star medals (one with valor), 33 Air Medals, the Vietnam Armed Forces Honor Medal, four Meritorious Service Medals, and four Air Force Commendation Medals. The Robert A. McAllister Firefighter Heroism Award was presented annually to personnel who displayed "acts of heroism above and beyond the call of duty."[375]

Force Protection

Following the terrorist attacks on September 11, 2001, CONUS installations adopted tighter measures for force protection and security. The Air Force Director of Plans and Programs ordered all CONUS bases to increase their levels of force protection through 100 percent identification checks and adoption of a range of protective measures. AMC took the lead in implementing force protection measures. AMC established force protection sustainment teams to visit each installation and evaluate existing security measures. A three-step plan to "detect, deter and defeat potential threats" was developed. The first step focused on the perimeters of the installations.[376]

In less than two years, AMC executed more than 100 projects across the command's 12 bases and increased the security at 29 entry points. The AMC command-wide gate construction program set new standards for air bases. As Joe Markin, chief of AMC's antiterrorism program, explained, "With the emphasis on detecting, defending and defeating terrorists, we realized we could no longer do business with an entry control point defined as a gate, a guard and a gun." [377] Two changes implemented at the 12 bases were a new traffic plan and a new gate design. New designs incorporated the latest in technology including "Smart Gate entry control technologies, surveillance cameras, visitor check-in kiosks and vehicle scanning technology."[378]

The *AF Entry Control Facility Design Guide* was published in February 2003 based on the studies completed by AMC.[379] At AMC installations, each gate was designed to be architecturally compatible with the base master plan.

New DoD Antiterrorism Construction Standards went into effect with the FY04 program. The new standards mandated that projects involving existing buildings were required to adhere to DoD standards in cases where renovation surpassed 50 percent of replacement costs or involved a conversion in use. Compliance with the standards was mandated for all new construction projects. The standards focused on maximizing standoff distances, providing stronger structural systems to prevent building collapse, minimizing hazardous flying debris, and limiting airborne contaminants.[380]

Disaster Preparedness Program

The Air Force Disaster Preparedness Program was substantially reshaped to reflect readiness priorities as a result of the September 11, 2001 attacks. Full Spectrum Threat Response (FSTR) replaced the former program and expanded personnel training requirements. On January 1, 2006, FSTR was expanded and renamed Air Force Emergency Management (AFEM) to reflect the heightened threat of weapons of mass destruction (WMD) and hazardous materials (HAZMAT).[381] The revised program integrated essential components identified in the National Response Plan and the National Incident Management System. DoD required all agencies to adopt the National Incident Management System and, in March 2006, the Air Force created its own version, Air Force Incident Management System. Both systems focused on a unified and comprehensive response among emergency responders, at all levels, to hazards. Changes in the structure and role of AFEM personnel were described in AFI 10-2501, *Emergency Management (EM) Program Planning and Operations*, published in 2006.[382]

New training included response to terrorist threats and acts, weapons of mass destruction, and improvised explosive devices.[383] The FSTR Division at AFCESA reviewed and developed several documents in 2001 to assist training and technical matters including AF Visual Aid (AFVA) 10-2512, *Mission Oriented Protective Postures*, AFVA 10-2511, *USAF Standardized Attack Warning Signals*, AFI 10-2602, *Nuclear, Biological, Chemical Warfare Defense Operations*, AFI-10-2501, *Full Spectrum Threat Response Planning and Operations*, and AFH 10-2502, *USAF Weapons of Mass Destruction (WMD) Threat Planning and Response Handbook*.[384]

Airfield Obstructions Initiative

Several investigations ensued after an F-16 accident in 1998 resulted in a pilot fatality. The aircraft had crashed into the approach lights and parts of the instrument landing system after an aborted takeoff.[385] The Safety Investigation Board report and the Secretary of the Air Force Inspector General Report of Review identified airfield designs and airfield obstructions as contributing factors to the accident. The reports included recommendations for improving airfield design standards and requirements. Specifically, the Safety Investigation Board recommended that the Air Force implement the Federal Aviation Administration standards for Low-Impact Resistant Structures and identify all non-frangible structures near runways for removal or replacement.[386] Maj. Gen. Earnest O. Robbins II, The Civil Engineer, authorized a Tiger Team headed by his executive officer, Lt. Col. Kurt Kaisler, to evaluate the Inspector General's report, to assess Air Force airfields, and to recommend new standards.[387] Simultaneously, the Chief of Safety, the Deputy Chief of Staff for Air and Space Operations, and The Civil Engineer directed the major commands to identify all obstructions and estimate removal costs. Over 9,900 obstructions were inventoried by major commands; 2,000 obstructions were located within 1,000 feet of the runway. Colonel Kaisler's Tiger Team established the goal of removing all high-risk obstructions by 2010. In 2000, the team published an Airfield Obstruction Reduction Initiative Report, which included additional recommendations.[388] In response to the Inspector General's report, the Tiger Team produced a revised Engineering Technical Letter 88-4, Reliability and Maintainability Design Checklist, a revised AFMAN 32-1123, *Airfield and Heliport Planning and Design*, and an Engineering Technical Letter on Standard Frangible Designs.[389] In January 2001, Headquarters, U.S. Air Force and the Secretary of the Air Force approved the Tiger Team's recommendations and approved funding to remove airfield obstructions from FY03 through FY10.[390]

EOD

The Air Force's Military Munitions Response Program, begun in 2001, was established to evaluate ranges for unexploded ordnance and to clear explosives hazards. The program extended to 81 bases and 507 sites comprising 500,000-acres in CONUS.[391] In February 2001, EOD team members visited

Vandenberg AFB, California, to evaluate former World War II ranges and developed site plans for clearing hazards.[392] Range clearance continued throughout the decade.

In 2007, General Eulberg established the EOD Optimization Integrated Process Team (IPT) to assess EOD staffing requirements for flights. The IPT evaluated the current manpower and determined the level required to sustain operations for missions at home and while deployed. The Civil Engineer Readiness Council accepted the IPT's recommendations to create four standard EOD flight sizes: 60 personnel for large range flight, 24 personnel for large projection flight, 17 personnel for small projection flight, and 12 personnel each for two Korean defense flights. Due to this assessment, 159 new enlisted positions and 22 new EOD-qualified officer positions were created along with 3 new flights at Wright-Patterson AFB, Ohio; Offutt AFB, Nebraska; and, Tinker AFB; Oklahoma.[393]

During the decade, equipment and technology for EOD personnel evolved to address the hazards of explosives handling. Robots were designed with a variety of applications, particularly in deployed situations. The Bombot allowed team members to safely countercharge improvised explosive devices from a distance. The All-Purpose Remote Transport System with attachments could clear buried ordnance and minefields. One commercial technology adapted by EOD personnel was the Segway Human Transporter. This vehicle provided transport at 12 miles per hour for EOD personnel clad in 70-pound bomb suits. The Segways were maneuverable and responsive in most terrains, with the exception of deep sand. By 2004, four Air Force EOD units utilized Segways. These vehicles, which did not contain systems or materials that posed a detonation danger, were customized with saddlebags and a trailer to carry extra gear.[394] The Bomb Squad Emergency Response Vehicle, a standardized truck with multiple storage compartments that carried an EOD team's equipment during an incident response, was also developed to provide a "toolbox on wheels."[395]

Environmental Programs

Air Force environmental programs marked a number of milestones in the first decade of the twenty-first century. Air Force civil engineers continued to emphasize resource stewardship, which included compliance with the Native American Graves Protection and Repatriation Act and the National Historic Preservation Act of 1966, the conservation of wetlands, and installation cleanup. On May 15, 2001, the Air Force repatriated human remains and funerary items removed from Shemya Island, Alaska, during a runway construction project in 1943. Complying with National American Graves Protection and Repatriation Act, cultural resource managers of the 611th Air Support Group at Elmendorf AFB, Alaska, completed the necessary consultation and repatriation to the Aleut Corporation.[396]

The preservation of historic resources on Air Force installations also was addressed by Air Force civil engineers. F.E. Warren AFB, Wyoming, completed a $28 million lead-based paint renovation project in 2005. The project focused on an area containing 155 historic brick dwellings listed on the National Register of Historic Places. The project was completed in accordance with the *Secretary of Interior's Standards for the Treatment of Historic Properties.*[397]

Air Force civil engineers continued to adopt experimental and innovative methods for effective environmental cleanup. In 2001, Lackland AFB, Texas, applied a process to contain lead in the treatment of 70,000 cubic yards of soil under its Soil Reuse Plan. The process blended environmentally safe chemicals into lead-contaminated soil; the chemicals worked as an adhesive agent to confine the lead in place. In accordance with the Soil Reuse Plan, the treated soil was used to cap an old landfill on the base. An additional 25,000 cubic yards of lead-free soil was added to the site, and grass was planted to prevent erosion.[398]

Installation Restoration Programs (IRP) continued throughout the first decade of the twenty-first century. In 2006, Dover AFB, Delaware, met its goal for in-progress remediation for all contaminated sites. The IRP at Dover AFB comprised 59 sites listed as Superfund National Priorities since 1989. Accelerated anaerobic biodegradation was used in the cleanup process. The biodegradation process used native bacteria to break down hazardous contaminants into safe compounds.[399]

The extended IRP at Johnston Atoll in the Pacific Ocean was completed. Civil engineers from Hickam AFB, Hawaii, contributed to the environmental cleanup project. The 15th Air Base Wing, Detachment 1 was responsible for host management duties at the site. Demolition and cleanup plans were developed by AFCEE, the U.S. Army, the Defense Threat Reduction Agency, EPA, the U.S. Fish and Wildlife Service, and the National Oceanic and Atmospheric Agency in 2001. The FY02 and FY03 project costs included $26 million for demolition and an additional $20 million for environmental cleanup.[400] Eight sites were contaminated with petroleum, dioxins, and metal residues. Heat treatment was used to decontaminate the soil containing dioxin residue. All structures were dismantled, "clean" wood was incinerated, concrete debris was buried, and recyclable materials were transported to the mainland for disposal. On June 15, 2004, all personnel vacated Johnston Island and the site was dedicated as a wildlife refuge.[401]

Air Force civil engineers adopted environmentally friendly construction practices. On December 19, 2001, General Robbins released a Sustainable Development Policy that stated, "It is Air Force policy to apply sustainable development concepts in the planning, design, construction, environmental management, operation, maintenance and disposal of facilities and infrastructure projects, consistent with budget and mission requirements." He went on to recommend the LEED system as the preferred self-assessment metric.[402]

On July 31, 2007, General Eulberg signed the Air Force Sustainable Design and Development Policy establishing goals and responsibilities to fully integrate sustainable building practices in the facility construction program.[403] The Air Force endorsed the LEED program and established a goal for new construction to meet LEED silver rating criteria beginning in 2007.[404] To achieve LEED certification, buildings were constructed with recycled or recyclable materials, and outfitted with efficient utility systems to the greatest extent possible. Building materials were free of potentially harmful chemicals as well.[405] Personnel from AFCEE and AFCESA published the Engineering Technical Letter 08-13 "Incorporating Sustainable Design and Development and Facility Energy Attributes in the Air Force Construction Program" to assist civil engineers in meeting sustainable practices.[406]

Keesler AFB, Mississippi, became the first Air Force installation to attain LEED-certification for housing. The construction project at Keesler AFB was the nation's largest LEED-certified project; it involved 700 houses.[407] Edwards AFB, California, and Shaw AFB, South Carolina, also achieved LEED Silver certifications for construction projects. A Consolidated Support Facility at Edwards AFB featured thermal storage, low-volatile organic compound paint, and energy efficient lighting. A 144-person dormitory at Shaw AFB integrated "an efficient building envelope" and ground source heat pumps, among other energy saving techniques.[408] The Tyndall AFB, Florida, Physical Fitness Center was the first Air Force facility to achieve LEED Platinum status in 2011.[409]

In November, 2007, Peterson AFB, Colorado, became the first base to install a green roof. Adoption of vegetative roofs reduced energy consumption, which contributed to Federally-mandated energy reduction goals, as well as meeting LEED criteria. Before a vegetative roof could be installed, a thorough structural analysis was completed to evaluate the structure's capacity to support the additional weight of vegetation, soil, and support systems.[410]

Energy and Water Conservation Programs

The Air Force's outstanding work in energy conservation and water management routinely has been acknowledged publicly through awards and honors. The Air Force continued to lead the U.S. Armed Services in meeting energy conservation goals and implementing renewable energy strategies. Dyess AFB, Texas, received DOE's Water Conservation/Beneficial Landscaping Award on October 12, 2000 recognizing its 30 percent reduction in water consumption. Randolph AFB, Texas, also received the same award in 2000. AFCESA received DOE's Alternative Financing Projects Award in 2000 for use of Energy Savings Performance Contracts (ESPCs).[411] In 2001, the Air Force received five Secretary of Defense Environmental Security Awards followed by six Federal Energy and Water Management Awards in 2002.[412] Goodfellow AFB, Texas, won the Water Management Award to Small Groups for reducing water consumption by 32 percent. Fairchild AFB, Washington, received the 2002 Innovative/New Technology Award to Individuals for construction of an 11-acre building that utilized infrared radiant heating and light pipe technology.[413] In 2006, the Air Force Facility Energy Program was recognized for its achievements when the EPA awarded the Air Force with the Climate Protection Award and the Green Power Partner of the Year Award for its purchases of renewable energy.[414]

The Air Force's energy goals remained consistent throughout the decade: "to reduce demand through conservation and efficiency; increase supply through alternative energy sources and create a culture where all Airmen make energy a consideration in all we do."[415] The Energy Policy Act of 2005 mandated additional goals and standards for Federal agencies. The Act focused on renewable energy and conservation. A two percent reduction in energy consumption was imposed beginning in 2006. For FY07 through FY09, a minimum of three percent of electrical energy was to come from renewable sources.[416] Section 103 of the 2005 Act directed that all Federal agencies install meters on individual buildings, where cost effective, by October 1, 2012.[417] The mandate for metering use of electric, natural gas, and water was further promoted in the 2008 Air Force Infrastructure Energy Strategic Plan.

In 2008, the Civil Engineering and Logistics fields developed the Air Force Infrastructure Energy Strategic Plan.[418] The plan contained goals to "increase use of renewable energy sources as well as produce more…on Air Force bases."[419] The plan rested on four pillars: improve current infrastructure, improve future infrastructure, expand renewables, and manage costs.[420] The Air Force Infrastructure Energy Strategic Plan recommended that Air Force civil engineers consider more than the immediate impact on their installation and work with the public and private sectors in achieving common energy conservation goals. The 2008 plan carried forward several energy goals from the 2007 Energy Independence and Security Act, one of which called for the annual energy reduction of 30 percent by 2015 based on FY03 baseline usage.[421] The Air Force Facility Energy Center recommended the continued use of Energy Savings Performance Contracts, Utility Energy Services Contracts, and Enhanced Use Leases to meet energy goals. The 2008 Air Force Infrastructure Energy Strategic Plan was unique in that it included goals for both "traditional 'built' infrastructure" and "natural infrastructure, vehicles, and ground fuel initiatives."[422] With implementation of the plan, the Air Force again became the "first Service to publish a holistic infrastructure energy plan to support the Office of the Secretary of Defense Strategic Plan and White House Executive Orders."[423]

During March 2007, the Air Force chose two bases to participate in the Air Force's Model Energy Base Initiative: McGuire AFB, New Jersey, and Barksdale AFB, Louisiana. McGuire AFB quickly adopted a "multi-faceted energy awareness program" and instituted goals to make all facilities energy neutral by 2015.[424]

Air Force Bases were encouraged to purchase energy from renewable sources and to assist in complying with Federal directives to "increase the use of renewable energy and to reduce total energy usage."[425] Edwards AFB, California, became the first Air Force installation to make a major purchase of renewable energy, 33 gigawatt-hours in July 2001. During FY03, Dyess AFB, Texas led the Air Force in renewable energy purchases, securing 78 gigawatt-hours to fill 100 percent of base requirements.[426] Dyess AFB and Fairchild AFB, Washington, were two installations contributing to the Air Force renewable energy success. Electric power used for both installations was 100 percent from renewable sources.[427] The Air Force was one of the first organizations in the world to purchase an excess of one million megawatts of renewable energy.[428] During FY09, the Air Force surpassed its renewable energy goal of 5 percent by utilizing 5.8 percent renewable energy sources. The achievement marked the first time that the DoD goal was met without purchasing renewable energy credits.[429]

To ensure compliance with renewable energy mandates and goals, the Air Force also increased the number of energy projects at installations. Hill AFB, Utah, harnessed biomass renewable energy using methane gas from a local landfill. The methane gas, emitted from decomposing waste, produced

2.3 megawatts of electricity and saved approximately $400,000 in energy costs per year.[430] Another promising renewable energy technology was plasma waste-to-energy systems. The plasma waste-to-energy system converted the "organic portion of waste into a synthesis gas to feed electricity-producing generators; the inorganic portion is converted into glass-like slag used as aggregate for construction purposes." The system purchased for use at Hurlburt Field, Florida, reduced solid waste by 90 percent and converted the remaining 10 percent into recyclable material.[431] By 2010, 45 installations were developing renewable energy projects incorporating geothermal, solar, wind, or waste-to-energy sources. Projects included a biomass plant at Eglin AFB, Florida; a geothermal well at Mountain Home AFB, Idaho; and, net zero installation at USAFA, Colorado.[432]

Wind and solar energy projects remained the most popular types of renewable energy projects at Air Force installations during the early part of the decade. In 1996, the Air Force erected four 225-kW wind turbines at Ascension Island in the Atlantic Ocean. Prior to the wind turbines, oil-fired generators were the island's main source of energy. Within five years, Ascension Island conserved 287,000 gallons of fuel oil, saving approximately $350,000 each year.[433] The wind project was funded through DoD's Energy Conservation Improvement Program. Two additional wind turbines were erected on Ascension Island in 2003. Shortly after the first phase of construction, the Air Force won a 1997 DOE Small Group Renewable Energy Award. The second phase of construction won the 2004 Citation Award for Design Excellence and tripled the total project power output to 9500 MW per year.[434]

Use of wind power was an integral part of DoD's drive to reduce dependence on fossil fuels by seven percent by the year 2010. Other renewable energy sources included solar and hydrogen energy. In 2002, Lackland AFB, Texas, joined the growing ranks of installations incorporating "windtricity" into its energy program. Lackland AFB purchased renewable energy from local power companies as part of the DoD-wide goal to decrease fossil fuel reliance.[435] The energy was generated by the Desert Sky Wind Project located 12 miles northwest of the town of Iraan in west Texas. Lackland AFB received $54,000 for the first year of a renewable energy source project, part of a 5-year $500,000 program included in the FY02 Defense Appropriation Bill. The $54,000 provided an estimated 1.8 million kWh

The Nellis AFB solar array was one of the largest in North America when it was constructed in 2007.

or 18,000 blocks of windtricity each year. The wind farm was capable of generating 160.5-megawatts through 107 wind turbines spread over a 15-square mile mesa.[436]

Tin City Long Range Radar Station (LRRS), Alaska, was another wind power energy success story. In 2009, the first wind turbine was installed by the 611th CES. Power from the project saved an estimated 85,000 gallons of fuel, approximately 30 to 35 percent of the annual fuel consumption at Tin City LRRS. Engineers and contractors developed new technology to combat the frigid climate during installation of the wind turbine. A system was devised to carry warm air through the base of the turbine and out the tips of the blades to eliminate icing. "Passive solar blade heating and low-temperature lubrication of the nacelle" also were utilized to prevent the turbine from freezing.[437]

Solar energy was utilized in many different ways by Air Force civil engineers. On December 17, 2007, Nellis AFB, Nevada, began generating approximately 25 percent of the base's electricity through solar energy. The solar field spanned 140 acres and contained 72,000 solar panels. The project was one of the largest in North America at the time of its installation.[438] SolarWall technology also provided a cost-effective way to heat and cool buildings. This technology was in use on select buildings at Edwards AFB, California and Buckley AFB, Colorado. At Buckley AFB, Colorado, the SolarWall was installed on a 5,000 square-foot building. The 1,000 square-foot Solar Wall was built in front of one exterior wall. The "cool air [is] drawn into the perforated metal wall, [which] is heated by the sun. A small interior make-up fan draws the warmed air into a perforated soft duct system extending the length of the building. Ventilation holes in the duct system allow air to be directed upwards towards the ceiling to create convection currents that move warm air throughout the entire building."[439]

Along with energy conservation, the Air Force implemented a water conservation program at several bases. The Energy Independence and Security Act dictated a two percent annual reduction based on an FY06 water usage baseline.[440] National policy encouraged Federal agencies to consider alternative sources of water. Utilizing a 2007 baseline, reduction targets for potable water consumption were established at 16 percent by the end of 2015. Alternate water sources included reclaimed water, gray water, captured rainwater, industrial gray water, and non-potable well water. The primary alternate water source used in the Air Force was reclaimed water for irrigation purposes. Edwards AFB used treated discharge and the USAFA purchased reclaimed water for irrigation.[441] The Air Force had plans to implement gray water systems in base facilities.

Other water conservation initiatives undertaken by the Air Force included the effluent water system at Dyess AFB. In 2002, the 7th CES joined Abilene, Texas, to use effluent water to irrigate landscaping. Due to drought cycles in the Abilene area, the city instituted a water conservation program using effluent water to irrigate golf courses and turf grass areas. Turf grass was a natural cleanser for partially treated water and acted as a filter before the water reached streams, rivers, and lakes. Dyess AFB entered into a ten-year contract with Abilene to use effluent water on the installation's irrigation projects. The installation simultaneously erected two, 11 million-gallon holding-reservoirs and two pump stations. The effluent water project saved over 160 million gallons of potable water annually.[442]

The Air Force Scientific Advisory Board (SAB) completed three Alternative Base Energy (ABE) studies in 2009. The ABE evaluated ways that the Air Force might ensure electrical power to installations while diminishing the use of fossil fuels as a generating source, thus meeting Federal, local and Air Force energy policies. The studies responded, in part, to the Defense Science Board's 2008 report on the DoD Energy Strategy, which emphasized the necessity of ensuring that all military installations had sufficient sources of electricity at all times. The ABE studies presented an analysis of several Air Force installations and the ideal energy generation sources for each. Additionally, security of the energy sources and storage facilities was highlighted. Alternative and emergency energy sources aside from the commercial transmission grid safeguarded the capability of the military to respond in any situation. Small nuclear power systems, which could be buried for higher security and reduced reliance on a public energy supplier, were encouraged by SAB.[443]

Automation

Automated Civil Engineer System (ACES)

In 2001, ACES remained on track for implementation for use Air Force wide. The Automation Steering Group reported that ACES achieved approval by the chief financial officer and received a Certificate of Networthiness in February 2001.[444] As the decade progressed, ACES replaced the older WIMS and IWIMS systems as the primary computerized management system used at Air Force bases.

By early 2001, the Air Force began investigating the potential of establishing a portal on the Internet. In spring 2000, the Air Force logistics community experimented with a prototype web-based portal using commercially available software. The prototype portal was successful and was expanded Air Force wide through the Global Combat Support System-Air Force Integration Framework. The portal allowed access to all unclassified combat/mission support and service applications by July 2001. Personnel were able to log onto the network once and access all programs as opposed to logging onto each individual program. A single portal assured that all Air Force personnel had access to the most current software and programs. During summer 2001, AFCESA worked with the Standard Systems Groups to migrate ACES to the web environment linked to the Air Force portal. By fall 2001, the ACES Program Management module was moved to the web. Other modules, such as the ACES Housing and Real Property modules, were scheduled to be web-based by February 2002. The programs were located in a virtual civil engineer community area established within the portal.[445]

Work continued on the ACES program. During 2003, the Deputy Civil Engineer, Ms. Kathleen I. Ferguson, chaired the Automation Steering Group. She recounted that ACES provided the "automated tools our installations and major commands need to do their job. It has a multitude of functionalities-operations, environmental, real property, housing and project management-those things our personnel need to do their jobs more effectively and efficiently."[446]

By 2004, the number of available ACES modules included Personnel and Readiness, Real Property, Program Management, Housing Management, Explosive Ordnance Disposal, and Fire Department. One module that proved problematic was ACES-Operations. The Air Force tried to customize commercial-off-the-shelf software, however, that was not as easy as it sounded. Civil Engineering shared data elements and interfaced with other systems such as the financial system and any software changes also affected those other systems. The software had limited sharing capabilities among users across the Air Force. Eventually, the attempt was left unfinished pending the development of the subsequent automation system. Training to use the system included classroom training, but the popularity of web-based training was increasing. Web-based training allowed greater access and flexibility to all Air Force civil engineers and was less costly than traditional classroom instruction.[447]

Agile Installation Management and Next Generation Information Technology (NexGen IT)

By 2007, discussions began on the next generation of information technology (NexGenIT). By that time, the Air Force had 800 individual databases, including those in ACES, IWIMS, and individual base and major command databases. Users of the ACES and IWIMS suites used the same software, but the databases generated by those software packages were stand-alone records and not linked to other data. General Eulberg related that the only way to determine the total number of Air Force real property assets was to manually enter the totals from each individual database onto a spread sheet. It was not possible to query a single database for that information. Establishing a single database became a goal of the IT transformation.[448]

The new Air Force civil engineer IT initiative was named Agile Installation Management (AIM). AIM was not a specific system or software program. The goal of AIM was to provide "the agility needed to easily manage our data from a complete CE enterprise perspective."[449] AIM focused on making all

Air Force civil engineer processes at the base level more effective and efficient and on enabling an enterprise view of installation assets.[450] The vision of AIM was expressed by General Eulberg,

> Our AIM initiative will enable real estate officers and planners to manage space to reduce the physical footprint of our facilities and our overall sustainment costs. It will enable engineers to plan and prioritize projects based on a standard set of business rules for facilities, airfields, road, or utilities that link priorities to mission-critical assets and common levels of service. It will enable strategic sourcing to maximize our buying power by consolidating all like purchases into one contract action…. And it will enable resource managers to capitalize all reimbursable costs and provide better management of our true costs of doing business.[451]

The IT transformation was driven from the top down. High-level mapping of the civil engineer business processes resulted in identifying the requirements for the next generation IT. To this end, The Civil Engineer established a new policy to centralize the acquisition, application, and implementation of new technology to avoid duplication of efforts and systems. All IT purchases of software, hardware, systems, or applications were validated through the Civil Engineer Investment Review governance process prior to approval by the Air Force or the OSD. This process imposed a discipline on customized IT software and applications. By 2008, Air Force civil engineering had eight different work order automation tools, ten different geospatial system architectures, four different airfield waiver applications, and five different emergency response tools. All future IT applications were required to serve the entire civil engineer enterprise.[452] During 2008-09, the Office of The Civil Engineer developed a concept of operations to create a centralized IT and Business Process Transformation Center of Excellence at the Air Staff and worked to establish a Civil Engineer Chief Information Officer position.[453] In 2009, the Resources Division in the Office of the Civil Engineer established the Information Technology Branch.[454]

The IT component of AIMS was called NexGen IT. One goal of the IT package was to consolidate all databases into a single, authoritative database in a Web setting that allowed real-time sharing of data among users across the civil engineer enterprise.[455] It also had to meet the requirements of the Secretary of the Air Force's Data Transparency Initiative. In fact, the days of custom-designed software unique to the Air Force, such as BEAMS, WIMS, or ACES, were over. The Civil Engineer proposed to use software already owned by the Air Force and adopt the best commercial-off-the-shelf (COTS) software solutions in real estate, space management, and computerized maintenance management system.[456] Implementation of NexGen IT used a multiple tier approach. The first focus was on the core resources areas of financial, personnel, and budget. The next tier was focused on real estate, work management, supply management, space management, energy, planning, and project management.[457]

Advances in IT accessibility were evident during the last years of the decade. In August 2008, real property, housing, project management, and environmental data were made available through the Air Force Portal to anyone with a Common Access Card. In addition, a system was made available that automated the paper forms for Work Requirements, Work Clearance, and Environmental Impact capabilities.[458] In 2009, the Office of The Civil Engineer reviewed more than 1,000 separate IT programs and applications in use throughout the civil engineer community. The majority of IT applications provided individual solutions that were not appropriate enterprise-wide. In addition, the systems did not communicate with other systems, and often the data was entered multiple times. Progress was made in reviewing the best commercial software applications available for implementation by Air Force civil engineers. The timetable to award software and service provider contracts was late 2009. Real estate and space planning programs were planned for initial implementation in 2010, followed by computerized maintenance management, energy, and project management programs in 2011.[459]

In January 2010, General Byers approved the NexGen IT Program Management Plan to guide the efforts over the next two years. General Byers stated,

> The strength of our technology is critical to our mission success. It must provide us with the reliable, up-to-date information we need to prioritize our projects, validate our funding requests, and support our Asset Management culture. We need to think and be more like Wal-Mart – delivering supplies and equipment to our Airmen when and where they need it.[460]

A major effort was to identify the data needed to manage Air Force civil engineer business processes, standardize the data, and clean up the data collected in the former automated systems of ACES and IWIMS. Some interim systems were in place that searched data in both ACES and IWIMS.[461] One resource was the S-File that collected interior space use data for all facilities in the Air Force real property inventory. The S-File provided accessible data on building floor plans, space assignments, and organization of every room in every building on every base. By the end of 2010, data collection for administrative buildings, which represented 21 percent of all Air Force facilities, was nearing completion.[462] The new IT package also was planned to give greater accessibility to all Airmen; be compatible with high-tech devices, such as scanners, used to capture and upload data; and, automatically program real property installed equipment and recurring facility maintenance activities.[463]

Air Force GeoBase

Mapping was one area that benefitted from automation, particularly through the use of the commercially-available geographic information system. Individual bases experimented with GIS mapping during the 1990s. Mapping often was accomplished by various groups on an installation for specific purposes, but the data was not assembled in one place or shared among flights at a base. The experience of the 10th CES at the U.S. Air Force Academy (USAFA) was typical of other installations. USAFA adopted GIS technology by 1992 and developed its own GIS maps for the USAFA using AutoCAD with a GeoSQL that linked the maps to WIMS. USAFA named the system USAFA Information Management System. This system was used until 1998. Staff stated that the system was complicated to use, accessible only from one personal computer, and difficult to maintain.[464]

In 1996, the Congress passed the Information Technology Management Reform Act that required DoD and the U.S. Armed Services to appoint chief information officers to regulate investments in information technology. The Air Force conducted a three-year study to examine the increase and decline in use of GIS systems on installations. A new practical mapping proposal evolved as a result of this study. The proposal called for a "mission-centered, practical, planned approach to acquiring geospatial information resources with balanced attention to both the IT and the organization."[465] In 1998, the USAFA's Institute for Information Technology Applications, headed by Gen. James McCarthy (USAF, Retired) scoped out the concept for an Air Force application called GeoBase and an initial prototype was prepared. The prototype was tested for two years, then presented at a senior Air Force leadership conference in fall 2000.[466]

In 2001, General Robbins established a new Headquarters Air Force Geo Integration Office (HAF GIO) in the Office of The Civil Engineer. Col. Brian Cullis, who had championed the technology while assigned to the faculty at the US Air Force Academy, was appointed Chief of the HAF GIO.[467] In turn, the Office of The Civil Engineer established the base CES as the central point of contact for all base mapping. Consolidating the mapping function using GeoBase at the base-level CES eliminated redundant mapping processes. A group comprising representatives from the major commands, Air Staff, and FOAs, was formed to spearhead a GeoBase Initiative and to set policies and procedures. In January 2002, a GeoBase strategic plan was formulated. The main tenet of the strategic plan was summed up in the phrase "One Base…One Map." Guidelines included establishing a full-time GeoBase team at all civil engineer levels to identify, organize and apply GeoBase resources; adhering to the Air Force approved GeoBase information technology and data standards; using and maintaining current data in the system; and, avoiding wasteful redundancies by sharing data.[468] During 2002, the HAF GIO also received additional funding as a result of the attacks on September 11, 2001.[469] By 2003, each major command, AFCESA, AFCEE, and four other FOAs had established GIOs to integrate GeoBase into their operations and to use the system for a wide variety of applications.[470] In June 2003, an Air Force Garrison Mapping Concept of Operations Version 2.0 was issued.[471]

GeoBase had three components: Garrison GeoBase; Expeditionary GeoBase, also known as Geo-Reach; and, Strategic GeoBase. Garrison GeoBase was the installation mapping program for each permanent Air Force base. In October 2002, the Garrison GeoBase IT structure was approved for use.[472] The basis of the installation map was the Common Installation Picture (CIP) that was a high resolution base map typically generated from satellite imagery or aerial photography. Mission data sets were added to the base map. Mission data sets were defined as the geospatial data map layers that functional organizations on a particular base chose as vital to support their particular mission.[473]

On the installation level, the GeoBase program became the basis for installation comprehensive planning and provided detailed mapping of roads, buildings, installation boundaries, and utility systems. It was used to track environmental restoration sites, compliance, planning activities, and locations of cultural and historic properties. For example, the Vandenberg AFB, California, GIO compiled one of the largest databases in the Air Force to support the 30th Space Wing and all supporting agencies. Its GeoBase supported missile and space launches, EOD disposal management, airfield obstruction analysis, fire department fire modeling, toxic hazard modeling, disaster preparedness, and emergency response.[474]

GeoBase also was used to prepare specific maps to meet specific functional needs. For example, GeoBase was used to develop explosives site plans for all permanent bases. This was required after the implementation of new stricter explosives safety regulations. The Air Force was required to meet these new regulations on all bases by 2005. EOD personnel developed an automated explosives site planning software known as the Assessment System of Hazard Surveys that used a digital map populated with installation-specific data. The system generated the explosives site map and the appropriate Air Force form to file with the DoD Explosives Safety Board.[475]

The ARC also embraced GeoBase. By 2007, the Air Force Reserve Command (AFRC) had implemented GeoBase at 14 installations. This system incorporated more than 60 map services and more than 130 GIS layers. Access to the AFRC system was web-based. In the aftermath of Hurricane Katrina in 2005, the ANG Readiness Center used an application of GeoBase called Geo Base Engineering Toolkit to produce a beddown plan for 4,500 evacuees at England Air Park, Alexandria, Louisiana. Beddown planners from the 179th CES, Mansfield, Ohio, who had conducted the physical site survey, were able to confirm the presence of existing infrastructure, the locations of utilities, and availability of nearby amenities.[476]

Applications for using GeoBase were wider than just facility data. Operations Flight personnel were able to use the system to show approach and departure corridors for airfields and ranges. Data on bird aircraft strike hazards also were trackable using the system.

In addition to base mapping, GeoBase had a strategic and an expeditionary role. Launched in 2002, Strategic GeoBase provided Air Staff and DoD personnel an overview of all installation data for use in planning decisions that affected the bases. Questions answered by Strategic GeoBase included proximity of Air Force ranges to urban areas and national parks and other areas of political interest. It also was used to guide decisions about homeland defense planning, force protection strategies, and base closures and realignments. In 2004, the first Air Force-wide library of imagery acquired from commercial satellites was linked to the system to provide up-to-date information.[477]

Expeditionary GeoBase, also known as GeoReach, was used to assist contingency planners to scope out forward operating locations.[478] GeoReach used satellite data to produce real-time imagery to evaluate site conditions for potential forward operating locations and aided planning of potential bed-down requirements, such as aircraft parking and runway locations, and billet areas.[479] The system was used to select possible locations, to collect all available recent imagery and related data on proposed locations, to assess locations in terms of beddown requirements and potential layouts, and to enable the data to be shared on a secure network among civil engineers, logistics planners, operations, and deployed personnel. The system also supported all survey and on-the-ground construction activities, including surveying actual forward operating locations and mapping installed facilities and utilities. The system allowed for monitoring conditions and changes to overall planning as required to support continuing force deployments.[480]

PACAF was the first major command to acquire GeoReach and became the first to apply the program in a real world contingency planning situation during OEF. GeoReach was used to produce images of potential remote bare base beddown locations prior to inserting personnel on the ground. PACAF maintained the Air Force's GeoReach website. PACAF added six additional contract personnel to input data and was able to keep up with demands for information Air Force-wide. The PACAF website reached 843,000 hits during the first six months following the establishment of the website in July 2000.[481] Using GeoReach, Pentagon planners were able to assess potential beddown options in remote areas of Afghanistan in days rather than weeks. Planners were able to preview and determine if politically available locations matched force requirements in numbers of aircraft and personnel requiring beddown.[482]

USAFE used GeoReach to plan potential beddown locations for OIF. USAFE civil engineers prepared maps of 60 potential forward operating locations in 15 countries beginning in November 2002. USAFE established a GIO to use the system to prepare maps showing critical factors, such as aircraft parking areas, quantity-distance arcs for ammunition storage, fuel storage locations, and personnel beddown locations. GeoReach also was used to prepare materials to support pre-deployment site visits. Site planners arrived at locations with accurate maps and pre-assembled data to finalize beddown plans. Among the required equipment to complete the site visits were laptops containing GIS software, a portable color printer, and a Trimble global positioning system (GPS) backpack. Using GeoReach, GPS, and the Internet resulted in greater efficiencies in planning deployment locations.[483]

In January 2004, the Air Force contracted with Trimble to provide GPS surveying and mapping systems for use as part of the GeoBase Civil Engineering Program. Under the $5 million contract, Trimble supplied several types of GPS systems along with training. The GPS units allowed civil engineers to collect accurate data on physical assets and infrastructure on the permanent bases. It also assisted in data collection on the airfields and camps worldwide which were sustained by the Air Force civil engineers. A further application of the GPS system was to assist during community construction projects, and planning and recovery efforts following natural disasters.[484]

During 2004, the CIP data standards were approved. Major commands were instructed to adopt the CIP structure for maintaining database information by October 2005.[485] CIPS were prepared for all main operating bases throughout the Air Force by December 2005.[486]

By 2005, the focus of GeoBase had shifted from start-up mode to widening its application to support all situations and expanding access to all Air Force civil engineers. In April 2005, selected unclassified GeoBase imagery was loaded onto the Air Force portal and available for viewing by all Air Force personnel. A further step allowed access to unclassified information in each installation CIP for both permanent and expeditionary bases.[487]

By 2006, the goal for GeoBase expanded to "One Air Force…One Map." This meant that installation CIPs were similarly structured and standardized to support Air Force-wide queries. The Air Force GeoBase program developed quality assurance and quality control standards for CIPs to ensure that consistent, reliable, and verifiable mapping data were available. The first GeoBase Air Force

Instruction (AFI), AFI 32-10122, was issued to establish an Air Force-wide policy and to delineate roles and responsibilities for implementing installation GIS.[488] Another goal was to achieve the ability to allow all CIPs to be viewed through an Internet-centric viewer.[489]

A-76 process

The A-76 process for competitive outsourcing continued to impact the Air Force civil engineer community throughout the first decade of the twenty-first century. The A-76 outsourcing competitions for civil engineer services occurred in the Air Education and Training Command (AETC) and in the Air Force Materiel Command (AFMC). These commands did not necessarily require military personnel at bases to perform civil engineer functions. Air Combat Command (ACC) and Air Mobility Command (AMC) retained, for the most part, blue suit civil engineers at their bases due to readiness requirements.

During the early years of the decade, AETC was heavily involved in the A-76 process. By 2001, AETC had a variety of civil engineering organizations under its command. Some civil engineering squadrons and base operating support organizations were hybrids of outsourced services, civil service most efficient organizations, and military personnel. Installations with hybrid organizations were the operations flights at Goodfellow and Laughlin AFBs, Texas; Tyndall AFB, Florida; and, Columbus AFB, Mississippi. By 2001, AETC adopted the approach to outsource the entire CES with the exception of the fire departments and EOD flights at five installations while retaining the military CES at three bases. One AETC installation, Vance AFB, Oklahoma, had been entirely contractor operated for more than 20 years. The five bases selected for A-76 outsourcing competitions were Maxwell AFB, Alabama; Lackland, Randolph, and Sheppard AFBs, Texas; and, Keesler AFB, Mississippi. The three bases that retained military CESs were Little Rock AFB, Arkansas; Altus AFB, Oklahoma; and, Luke AFB, Arizona. In the opinion of Col. Rusty Gilbert, Civil Engineer for AETC, outsourcing was like putting the base operating support on a credit card. The Air Force was required to pay for the services forever and re-competes for the contract were anticipated. Cost avoidance was not the same as cost savings, Colonel Gilbert warned.[490]

The Air Force Space Command (AFSPC) was the fourth largest command in terms of facilities. By the end of 2000, AFSPC reported that the major command had reached the limit of those civil engineer functions that could be outsourced. AFSPC retained military personnel at five main bases who were assigned to AEF deployment rotations and met readiness requirements. The five bases were Peterson AFB, Colorado; Malmstrom AFB, Montana; Vandenberg AFB, California; Patrick AFB, Florida; and, F.E. Warren AFB, Wyoming. Even so, some civil engineer functions at these bases were outsourced. The civil engineer functions at other AFSPC installations typically were contracted out to the private sector, but some were most efficient organizations (MEOs) run by Federal employees. While no A-76 competitions were anticipated for new functions, previously awarded contracts were reaching their five-year limits and required re-competition by the end of 2000. In all cases, contracts administered by outside contractors were more expensive than the first bid. The new bids to cover base operations support cost the government more money.[491]

AFMC had a small military civil engineer contingent. AFMC's Civil Engineer, Mr. James R. Pennino, explained that the variety of facilities found on AFMC bases presented unique challenges to civil engineers serving the bases. Some of these challenging facilities were huge industrial repair shops; testing and evaluation facilities like wind tunnels; laboratories; and, even some bases where tenants had flying missions. Between 1995 and 2003, the staffing changes in AFMC were dramatic. In 1995, the major command employed 7,300 government civilian and military personnel; by 2003, that number was 3,900. In 1995, military personnel numbered 258 officers and 2,274 enlisted personnel; in 2003 the numbers were 81 officers and approximately 1,000 enlisted personnel. Government civilians numbered 2,250 personnel, augmented by approximately 3,000 contractors throughout the major command. Civil engineer functions at four bases were operated by contractors, while three bases retained active duty, in-house CESs. These bases were Eglin AFB, Florida; Hill AFB, Utah; and, Robins AFB, Georgia. MEOs operated civil engineering at Wright-Patterson AFB, Ohio, and Edwards AFB, California, and the environmental program at Tinker AFB, Oklahoma. In these cases, a small number of government employees provided oversight for the contracts. The result in both staffing configurations was that the same amount of work was done by far fewer persons.[492] In 2007, as part of the *Civil Engineer Transformation Plan*, the CE Groups at Robins AFB; Eglin AFB; and, Hill AFB, were reengineered to deal with the loss of more than 600 military positions during the manpower cuts resulting from PBD 720.[493]

The A-76 process also was applied to Air Force Reserve Command (AFRC) bases. By 2005, ten of the eleven major bases under the Air Force Reserve Command had completed the process. Nine bases were turned over to entirely civilian work forces, while one base was operated by a government MEO. No Base Civil Engineers at Reserve bases were military personnel. AFRC staffed only one or two full-time military positions at 57 other Air Force bases with Reserve units.[494]

Privatization Initiatives

Privatization initiatives for family housing and utilities offered substantial savings in manpower and operations and maintenance costs to the bases. The goal of privatizing approximately 70 percent of the Air Force's family housing units relieved individual bases of the maintenance and upkeep costs of housing areas. These activities became the responsibility of the private developers who leased the land, owned the housing and were responsible for upkeep, maintenance and operation of the housing for a 50-year period. Transferring these responsibilities represented substantial savings in the number of shop and maintenance personnel required at base level. Overall, the intent was for family housing privatization to be a lesser cost than having the Air Force continue to own and operate it. The cost analysis compared the Air Force ownership to include in-house operations and construction costs to the cost of providing a housing allowance to the service member. As the housing was no longer owned by the Government, the service members living in the privatized units could receive their housing allowance which was used to pay rent to the project owner and cover the cost of utilities and rental insurance. The service member could choose to live in the privatized housing or in the local community. AFCEE was charged with oversight of the Air Force housing privatization efforts. This family housing privatization program grew to more than 50,000 homes, a scale equal or larger than prior large housing construction programs such as the Wherry and the Capehart programs of the 1950's and 1960's, respectively.

The Air Force continued privatizing utilities as part of the Defense Reform Initiative Directive #9, passed in 1997, later revised in 1998 by #49. The reform required privatization of all "government-owned electric, water, wastewater, and natural gas utility system[s] unless security concerns required Federal ownership or privatization was uneconomical" by September 2003.[495] In 2001, the OSD published the Defense Planning Guidance mandating the revitalization of all infrastructure and facilities to a "minimally acceptable performance" level by 2010.[496] The Air Force identified 667 utility systems in its inventory across the spectrum of active, Guard, and Reserve installations worldwide. As of the end of March 2011, 150 utility systems were privatized (50 since the DoD directive), 129 were exempt, 156 were deferred, and 62 were owned-by-others. The remaining 170 systems were scheduled for evaluation.[497]

Base Realignment and Closure (BRAC) and Joint Basing

During the early years of the twenty-first century, the Air Force continued the base closure process on 32 installations closed between 1988 and 1995. The process comprised environmental cleanup and transfer of facilities and real property to local communities or to other Federal agencies. Environmental cleanup was overseen by AFCEE, while real property transactions were handled by the Air Force Base Conversion Agency, which became AFRPA in October 2002.

Discussions for another round of base closures to shed excess military property occurred during 2001. However, U.S. Congressional House and Senate negotiators did not agree and delayed the next round of base closures. Public Law 107-107 dated December 2001 postponed all new BRAC decisions until 2005.[498] The BRAC process remained the same as in the 1990s. DoD prepared recommendations for closure and realignment, which the Secretary of Defense submitted to a nine-member BRAC Commission. The members of the Commission were selected by the President and the House of Representatives and approved by the Senate. The BRAC Commission finalized the recommendations and presented them to the President to accept or reject. The President's acceptance of the BRAC Commission recommendations became final within 45 days unless the Congress passed a joint resolution to block the package. If the President rejected the package, the BRAC Commission had the opportunity to submit revised recommendations within a specific time frame.[499]

The BRAC process began in January 2004, when DoD requested the commanders of all military installations to assemble data on their installations, including operations, real property, personnel, and facilities. The assembled data was submitted for review by DoD and became the basis for making recommendations to the BRAC Commission.[500]

In September 2005, the BRAC Commission forwarded recommendations for base closings, base realignments, and joint basing to the President. The Commission altered several Air Force recommendations.[501] The President accepted the recommendations and the Congress did not block the package. Thus, the work began to implement the largest number of BRAC recommendations ever by September 2011. BRAC recommendations numbered 190, more than the number recommended by the four preceding BRAC commissions combined. Implementing all the BRAC recommendations required approximately 837 distinct actions across 160 bases DoD wide. Over 40 BRAC recommendations directly affected the Air Force.[502] Of these, 78 percent of the implementation actions were required by the ARC.[503]

General Fox wrote,

> The results of the 2005 Base Realignment and Closure (BRAC) jump-started Air Force transformation initiatives by maximizing the war fighting capabilities of our flying squadrons, realigning Air Force infrastructure with the future defense strategy and capitalizing on opportunities for joint activity. Implementation begins in earnest this year [2006], as we commence with environmental analysis processes to comply with the National Environmental Protection Act in tune with the planning and design efforts on $456 million in FY07 BRAC MILCON requirements. We are partnering with the other branches to develop business plans to implement the 182 closure or realignment recommendations approved in this round of BRAC. BRAC also included recommendations for the consolidation of installation management at 12 sites, with USAF being the designated lead service at half of those locations. USAF fully supports the joint basing concept. The intended efficiencies garnered by the consolidation of installation services will assist USAF in its own modernization efforts.[504]

Implementing the BRAC recommendations required an Air Force-wide effort. According to Ms. Kathleen I. Ferguson, Deputy Assistant Secretary of the Air Force for Installations, "Every major command, the Guard, the Reserve, and Headquarters Air Force have supported this effort with a team of dedicated professionals whose sole focus every day is to ensure the more than 400 actions required by the Air Force to implement BRAC happen on time, within budget and with minimal negative impact on our people and our mission."[505] Only five Air Force properties were scheduled for closure and another 12 were scheduled for realignment. Many BRAC recommendations resulted in consolidating functions.[506]

Air Force funding to implement BRAC totaled $3.9 billion in the budget years FY06-FY11. Funding was spent on facilities required to support the realigned units and their new missions at the expanded bases. Years 2006 and 2007 were spent developing implementation business and program plans and MILCON planning and design. Between 2005 and 2008, 152 BRAC-related actions were completed. These actions required 227 projects on 54 installations in 36 states valued at $2.5 billion. Two hundred sixty actions were completed between 2009 and 2011.[507]

One significant change in the 2005 BRAC process was the implementation of Joint Basing. Under the Joint Basing Initiative, 26 installations across the CONUS who either shared a common geographic boundary or existed within a relatively confined area were studied for opportunities to be operated as Joint Basing. Ten joint basing recommendations affected Air Force bases.[508] In each location, a primary installation support provider was selected after a review of each functional area at each installation by Service Standard Teams. While the Office of The Civil Engineer supported the joint basing concept, General Fox remained clear about the following points, "Our underlying precepts are that 1) Airmen will command Airmen, 2) Airmen will open and operate airfields, and 3) the Air Force will achieve improvements without negative impact to our warfighting capability. We will not support lower standards for our Airmen."[509] Following this study, 12 Joint Bases would emerge.

Three locations initially chosen to implement the Joint Basing Initiative were McChord AFB, Washington; McGuire AFB, New Jersey; and, Bolling AFB, Washington, D.C. By fall 2005, personnel from these installations already were working with their Navy and/or Army counterparts to accomplish joint basing.[510] Other Air Force installations recommended for joint basing were Andrews AFB, Maryland; Elmendorf AFB, Alaska; Hickam AFB, Hawaii; Randolph and Lackland AFBs, Texas; Langley AFB, Virginia; Charleston AFB, South Carolina; and, Andersen AFB, Guam.[511] In six instances, the Air Force became provider of base operations support. These were Joint Base Andrews-Naval Air Facility Washington, Maryland; Joint Base McGuire-Dix-Lakehurst, New Jersey; Joint Base Charleston, South Carolina; Joint Base Elmendorf-Richardson, Alaska; Joint Base San Antonio (Lackland-Randolph-Ft. Sam Houston), and Joint Base Langley-Eustis, Virginia. In four cases, the Air Force turned over base operations to another Service. These were Joint Region Marianas, Guam: Andersen AFB and Naval Base Guam; Anacostia-Bolling, Washington, D.C.; Pearl Harbor-Hickam, Hawaii; and, Ft. Lewis-McChord, Washington. In 2009, the first joint bases became fully operational. These were Andrews-Naval Air Facility Washington, McGuire-Ft. Dix-Lakehurst, and Joint Region Marianas, Guam. The other joint bases became fully operational in 2010.[512]

Overseas Closures

In 2005, Rhein-Main AB in Germany closed. This action was the result of negotiations between the United States and Germany. The Frankfurt Airport wanted to expand its operations and the United States agreed in 1999 to transfer Rhein-Main AB to Germany. It was the end of an era since the United States had occupied the base since April 1945 and it had served as the "Gateway to Europe" for most U.S. military personnel throughout the years. In order to facilitate the closure, U.S. activities were moved and consolidated at Ramstein and Spangdahlem ABs in Germany. The transition planning and construction took five years and was under the management of John Thompson, the Rhein-Main Transition Program Manager in the Program Management Office in USAFE. Ramstein AB became the primary reception hub for AMC airlift operations, while joint fighter and airlift operations were moved to Spangdahlem AB. (See Overseas Construction, USAFE)

CONSTRUCTION

CONUS Construction

The military construction (MILCON) program throughout the first decade of the twenty-first century was expended on new construction to modernize and upgrade infrastructure for new weapons systems, while older systems were dismantled. The Air Force funded projects that supported Airmen and their families, such as MFH and dormitories. The Air Force continued to improve living standards and the building of thriving communities.

Other construction projects were financed through different funding sources. For example, early in the decade funds available to improve base security increased for permanent Air Force bases in CONUS and abroad. More than $630 million were requested in the FY03 Defense Emergency Response Funds to install base security measures and build up equipment to improve force protection capabilities.[513] Later in the decade, the American Recovery and Reinvestment Act of 2009 allocated $7.4 billion to defense agencies, of which the Air Force received $1.7 billion. The funds financed S/R&M projects and the construction of dormitories at two bases, child development centers at seven installations, and MFH projects at two bases, as well as other Air Force improvement programs.[514]

The MILCON budget at the beginning of the decade was $1.1 billion. In FY01, the Congress increased the MILCON budget for the Air Force by adding 62 projects. With the increase, 13 dormitories, 3 child development centers, 6 physical fitness centers, and many operational facilities were constructed.[515] The MILCON budget for FY04 was the largest budget award in 14 years. The $1.64 billion program covered new mission beddowns, ongoing mission requirements, quality-of-life improvements, and compliance initiatives for energy and environmental regulations.[516] After mid-decade, the MILCON budget declined somewhat as the Air Force chose to spend money on upgrading outdated weapons systems. The FY11 MILCON budget was $1.5 billion.[517]

Several installations in the United States entered into large construction projects. Charleston AFB, South Carolina, built a 55,000 square-foot corrosion control facility for $18.1 million. The installation entered into a new contract where the chosen firm was responsible for all aspects of construction, including design.[518] At Whiteman AFB, Missouri, a major construction program, begun in 1988 at a cost of $800 million, was completed in 2007. Approximately 99 percent of installation facilities were new. This effort replaced World War II wooden buildings and prepared for the B-2 bomber mission.[519] In Virginia, Langley AFB gained a new mission to replace F-15C Eagles with F/A 22 Raptors, which necessitated a major beddown project from 2002-05. The $105 million MILCON project funded the construction of three new hangars for the new aircraft, a new base operations facility, a flight simulator, and a low observable/composite repair facility. The new facilities at Langley AFB received several design awards, including the 2005 Honor Award for Facility Design and the 2005 Merit Award in the ACC Design Award Competition.[520] AFMC managed nearly $450 million in MILCON projects including construction of a $21 million test facility complex at Edwards AFB, California, for the new joint strike fighter aircraft.[521]

The Family Housing Master Plan combined MFH construction funds, operations and maintenance funds, and privatization to ensure adequate housing for Airmen by 2010.[522] The Family Housing Master Plan in 2001 supported revitalization of housing at PACAF installations. Through the plan, funds were budgeted to construct or renovate units to standards approved by the Air Force. Through MILCON budgets, Hickam AFB, Hawaii, replaced 102 housing units and 501 additional units were improved PACAF-wide in 2002 at a cost of $102 million. At the same time, the Family Housing Master Plan supported funding allocations of $155 million to replace 761 housing units and to improve nearly 3,700 units, while privatization efforts at PACAF led to the improvement of 2,070 units. By 2011, host nation agreements replaced 3,300 units at Kadena AB and Misawa AB, Japan.[523]

The goal of the Air Force Dormitory Plan was to upgrade all dormitories to current standards by

2009. In 2002, 3,900 of the 66,700 units in the Air Force inventory did not meet the Air Force standards. The FY03 dormitory program allocated $135 million to improve 11 enlisted Airmen's dormitories.[524] A new dormitory housing standard, Dorms-4-Airmen, was approved by the Chief Master Sergeant of the Air Force (CMSAF) and Chief of Staff in the early 2000s for unaccompanied personnel. The first quad-style dormitory was erected at Nellis AFB, Nevada, in 2004 and opened by CMSAF Gerald R. Murray. Each quad housed four Airmen in private rooms with private bathrooms that contained a full-sized bathtub. The common living area was shared by the four Airmen and was equipped with a full-sized refrigerator, microwave, stove top, kitchen table, ceiling fan, stereo, and a private balcony. The dormitory at Nellis AFB comprised 36 quads and housed 144 Airmen.[525]

MILCON budgeting for FY04 funded $1.5 billion in MFH construction and $128 million directed for dormitory construction. Over 10,000 housing units were either renovated or constructed, a move towards eliminating all inferior housing domestically by 2007 and by 2009 overseas. Unaccompanied personnel housing was increased by 1,104 rooms in 2004.[526]

In 2006, the Air Force constructed 5,104 MFH through a MILCON budget of $1.2 billion. Part of the budget and construction effort included the single largest MFH endeavor undertaken by the Air Force. Following the devastation of Hurricane Katrina, Keesler AFB, Mississippi, was in need of emergency housing and facilities; $264 million of the MILCON budget was utilized to provide 1,067 houses.[527]

The "Building Thriving Housing Communities Strategy" was developed by Air Force civil engineers in 2009 to improve the condition of both family and unaccompanied housing. The strategy was based on the Air Force's definition of a thriving community as "a safe, secure place for Airmen and their families to work, live, and play comfortably, with access to quality schools, health care, child care, dining, and other support services."[528] New design concepts focused on more than providing quality, modern housing for Airmen. The strategy extended to the community and included designs for neighborhoods with amenities for families.

The Air Force's total infrastructure budget request for FY11 was $5.5 billion, of which $3.1 billion focused on facility maintenance and repair. The MILCON portion of the budget was $1.5 billion, with continued emphasis on providing superior housing for families and Airmen. Of the total budget, $600 million was designated for sustaining and renovating overseas housing and privatization of housing in CONUS. Approximately $78 million of MILCON funding was requested for MFH programs to eliminate substandard housing in Alaska and Hawaii through privatization.[529]

Overseas Construction

USAFE

During the early years of the twenty-first century, USAFE received generous funding through S/R&M. Construction and renovation projects at installations throughout Europe greatly improved the working and living conditions of Airmen. Family housing and unaccompanied personnel housing were two major areas to receive funding. USAFE established goals to replace stairwell apartment housing with duplexes and townhouses for families. Build-lease construction programs for MFH were started in Germany, United Kingdom, and Italy.[530]

The Aviano 2000 construction project continued from the preceding decade. As individual projects began to lag, an Aviano 2000 Program Management Office was established in 1999 to ensure the timely completion of construction, as well as to free the wing commander to focus on the 31st FW flying mission.[531] Col. Gary C. LaGassey was appointed the program manager in February 1999. One project required a feasibility study to evaluate force protection capability and traffic reduction. Alarm had been raised when an explosive device was tossed onto the installation over a fence that separated the air base from the public road. The study was completed in 2001, and, by March 2004, all four concerned parties (U.S. Air Force, Italian Air Force, Province of Pordenone, and the City) had signed an agreement for land transfers and project construction, known as the Bretella Project. The $5 million Bretella Project centered on the consolidation of Area A1 and Area A2 at Aviano AB separated by Via Pedemonte.[532] One aspect of the project was to close public access to Via Pedemonte, which connected Aviano with the small town of Pedemonte. To increase force protection at the base, additional property was acquired by the Italian Air Force and alternate transportation routes and gates were constructed.[533] Sixteen projects were completed in 2004 comprising dormitories, a consolidated school, and base exchange/commissary. Construction projects for FY05 included a flight simulator, weapons load/maintenance training facility, aircraft ramp, and relocation of the MFH office onto the installation.[534]

A second, large ongoing construction project was underway in Germany linked to the final closure of Rhein-Main AB. In March 1998, negotiations began between Germany and USAFE regarding the closure of Rhein-Main AB. The final agreement was signed on December 23, 1999 with the following provisions: real property of Rhein-Main AB would be vacated by the U.S. Air Force by December 31, 2005 and the remaining missions transferred to Ramstein and Spangdahlem ABs. Prior to the closure of the base, an environmental assessment was completed, which resulted in the identification of several sites requiring cleanup. Cleanup costs of contaminated sites were shared among USAFE, the Frankfurt Flughafen, and the German government.[535]

New construction to facilitate the Rhein-Main Transition Program at Ramstein and Spangdahlem ABs required much planning and a large construction budget. Ramstein AB necessitated 14 projects involving either new construction or alteration work; the construction plan at Spangdahlem AB involved 23 major projects. Projects at Ramstein included demolition and reconstruction of runways and facilities. The new 10,500-foot runway was grooved to 16 inches to support heavy cargo aircraft. During runway construction, the alignment was shifted 3.8 degrees to keep within the base's

Construction of the Kaiserslautern Military Community Center at Ramstein AB, Germany.

boundaries. A new maintenance hangar for the C-130s was constructed along with a 90,417 square-foot freight terminal; a 79,653 square-foot fuel cell hangar; 400-person dormitory; and, a 200-person Temporary Living Facility.[536]

Construction efforts at Ramstein AB began shortly after the decision to transfer missions and personnel from Rhein-Main AB. A $355 million improvement plan was adopted and included the $150 million Kaiserslautern Military Community Center (KMCC), an 844,000 square-foot facility. The KMCC combined components of the Army and Air Forces Exchange Services (AAFES) and Air Force Services, while housing business and recreational venues. The new exchange was the largest AAFES exchange in the world and replaced existing exchanges at Ramstein and Vogelweh; it opened in September 2009.[537] An eight-story building containing 350 rooms for visiting quarters was part of the KMCC design. The overall project, the Defense Department's single largest construction project at the time, was plagued by construction problems, vandalism, and delays. One significant issue was the roof that required a major repair effort because of leaking.[538] Other improvements to Ramstein were taxiway and apron upgrades, a new passenger terminal, and a 24-hour flight kitchen.[539] Nearly 900 town houses were planned for construction at Ramstein and in the surrounding military communities, creating more than 2,600 housing units.[540] The runways at Ramstein again were improved in 2006; fully loaded heavy air transports were unable to use the runway during OEF and OIF. The north runway was extended by 1,000 feet.[541]

USAFE Construction and Training Squadron

The USAFE Construction and Training Squadron (CTS) celebrated its 50th anniversary of service in 2000. The CTS was first established on September 8, 1950 as the 7329th Labor Service Unit (LSU) serviced by civilians. The LSU was attached to the 862d Engineer Aviation Battalion stationed at Rhein-Main Air Base, Germany, until it moved to Ramstein AB, Germany in May 1952. In 1963, the 7329th LSU was designated the 7002d Civilian Service Unit and eight years later with the addition of military servicemen, the unit became the 7002d Civil Engineering Flight (CEF) and was known worldwide as "The Deuce." The 7219th and 2319th RED HORSE CEFs joined the 7002d in June 1990 and three years later the entire unit was redesignated the 702d CES. In July 1994, the unit again changed names, this time to the 617th CES. Finally in December 1997, the unit was designated the USAFE CTS with the mission of construction, training and maintaining aircraft arresting barriers. The CTS is the sole unit to operate the "only all-military, depot-level barrier overhaul function in the Air Force."[542] To commemorate the unit's 50th anniversary, USAFE commander Gen. Gregory S. Martin announced the USAFE CTS had "a long and rich tradition of service that arose out of the Berlin Airlift to shine in operations ranging from Norway to North Africa. Whether responding to high-priority, time-sensitive construction requirements, maintaining and repairing aircraft arresting systems, or training our own civil engineers, your work is marked by excellence."[543]

Spangdahlem AB also initiated a construction program to accommodate new aircraft as part of the Rhein-Main Transition Program. A 209,000 square-meter parking ramp and a 30,000 square-meter hot cargo pad were built; taxiways were extended and hardened. The acreage was expanded by 240 acres for the construction of the taxiway.[544] Additional construction at Spangdahlem AB included new housing; three 400-person dormitories; and, a 200-person Temporary Living Facility.[545]

In Great Britain, RAF Fairford underwent renovation in 2002 with a 10,000-foot runway upgrade, and repairs to the aprons and taxiways. The $80 million project was NATO-funded and completed in three phases, which allowed the base's mission to continue uninterrupted. All airfield lighting, jet fuel, and drainage systems were upgraded as part of the renovation project.[546]

PACAF

Andersen AFB, Guam, undertook a large MILCON program, which began in the early 2000s and continued throughout the decade. The first construction phase comprised three major projects valued at $177 million: a new 47,716 square-foot medical clinic; a 54,000 square-foot fitness center; and, a forward operating location aircraft hangar.[547] The $1.5 billion construction effort later in the decade was prompted by BRAC decisions, the Defense Posture Realignment Initiative, and the Strategic Policy Initiative. The result was to bed down Global Hawk aircraft at Andersen AFB, construct the Expeditionary Combat Support Campus at Northwest Field to house the 554th RED HORSE Squadron being transferred from Korea, build infrastructure to support the relocation of approximately 8,000 Marines, and support the U.S. Pacific Command's Global Strike Task Force through the establishment of "intelligence, surveillance, and reconnaissance aircraft; strike aircraft; and aerial refueling aircraft."[548] Specific tasks included construction of a clear-water rinse facility, a corrosion-control/composite-repair shop, dormitories, hangars, and a network of roads.

Alaska was home to a pair of significant engineering challenges at Shemya and at Elmendorf AFB. Eareckson AFS, Alaska, on Shemya Island first hosted an American military presence in World War II. Since then, the island on the western end of the Aleutian chain went through periods of great activity followed by years of diminished Air Force presence. In 2000, the United States announced plans to build X-band radar facilities at the site as part of the National Missile Defense system, along with systems at Fort Greeley, Alaska. Shemya was described as "a perfect location for the antiballistic missile radar, but it is a terrible place to try to build anything," by Col. Patrick M. Coullahan, Eleventh Air Force Civil Engineer. The weather conditions, logistical issues, and a tight timeline required significant planning and design challenges between the Air Force, Corps of Engineers, and Missile Defense Organization. The second project was a large MILCON program for the beddown of C-17 and F-22 aircraft. This included projects such as new hangars, shelters, simulators, pavements, utilities, and other support facilities built between 2005 and 2013.[549]

EDUCATION AND TRAINING

During the first decade of the twenty-first century, education and training initiatives for Air Force civil engineers were constrained by the Global War on Terror (GWOT). The constant rotation of military personnel limited the time available for coursework and exercises; it also limited the number of instructors and funding available to support programs. The Air Force faced challenges to maintaining a concise curriculum and to create programs that were readily available and easy to access at any time and any location. Computer-based training capabilities increased during this period to address the time limitations and instructor shortages created by the GWOT. In addition, the privatization of utilities during this period posed the potential to constrain training in water, sewage, and electrical proficiencies at bases across the CONUS. As a result, the Air Force partnered with private companies and schools specializing in vocational and technical training to adopt new ways of providing opportunities for military personnel to master the necessary skills associated with utilities.

Training in the past, such as that offered during Engineer Capstone Exercise '96, incorporated joint activities. A strategic effort to enhance joint training was initiated during the first decade of the twenty-first century. Joint training increasingly became necessary throughout the GWOT, particularly in situations where Air Force civil engineers regularly were tasked with working with and supporting other U.S. Armed Services. The primary goal of education and training was providing military personnel with the expertise to perform their jobs and to enhance their abilities to work in specific environments. In addition, the skills and knowledge gained were intended to enable personnel to advance to positions that fulfilled their professional aspirations.

Education

The educational opportunities offered by the Air Force Institute of Technology (AFIT) and the U.S. Air Force Academy (USAFA) afforded a broad range of options to engineering students. Programs and curriculum were constantly revised to present scholars with a spectrum of innovative hands-on learning experiences. Students also consistently were required to demonstrate proficiencies through practice scenarios. Unlike civilian institutions, AFIT and USAFA provided education specifically focused on military operations, practices, and organizations. In addition to presenting current material gathered from ongoing military activities, both institutions allowed students to work with personnel outside the campus, integrating scholars with professional organizations, active duty military, and private sector specialists. As a result of these educational opportunities, students developed knowledge in a variety of ways and were able to apply those lessons within diverse areas. These innovative approaches to education produced military personnel who were prepared to assume leadership roles, and who were confident in their capacity to respond to multiple responsibilities.

AFIT

AFIT continued to offer the Graduate Engineering and Environmental Management (GEEM) program through the first decade of the twenty-first century. Although students could choose between a civilian institution or AFIT, a degree from AFIT was preferred by many. The education offered by AFIT was tailored toward military engineer and environmental management fields. The GEEM engineering management program offered two tracks, a human resource management sequence and a quantitative decision-making sequence.[550]

The environmental management program offered an applied environmental sciences sequence and an environmental systems analysis and management sequence. The GEEM program was accredited by the North Central Association of Colleges and Schools. As a result, a degree from GEEM was equivalent to degrees offered by other accredited institutions. Students in the GEEM program completed 18 months of study, including 60 hours of courses and 12 hours of thesis work. Preferably, students entering the program had at least six years of active duty. This experience enabled students to better understand the complexities of military activities and to have a firm grasp of the program prerequisites. This level of experience was not always possible and many students entered the program with three or four years of active duty. Once a degree was conferred, graduates were required to fulfill a three-year Active Duty Service Commitment. Beginning in 2001, Civil Engineer Airmen also participated in the new Enlisted to AFIT program that permitted a small number of enlisted members to earn a master's degree through AFIT. Civil Engineering was at the forefront of this program, sending a civil engineer NCO for the first three years of the program.[551]

During AFIT's re-accreditation assessment in 2000, the Higher Learning Commission of the North Central Association of Colleges and Schools gave rave reviews to the GEEM program, as well as the other AFIT resident programs, including the Civil Engineer and Services School (CESS) and the School of Systems and Logistics. The commission described the GEEM program as "a credit to the nation," specifically because of the program's military focus. The curriculum, students, faculty, and campus resources were all considered superlative. Another benefit offered by AFIT was described by Col. George K. Haritos, who served as Commandant of AFIT during this period,

> another advantage we have over civilian institutions is that half our faculty members are military officers who stay here an average of only four years. This means we have a constant influx from the field, bringing the latest issues to the classroom. There is no way our program can become stale, because we know exactly what the Air Force needs.

This current knowledge proved to be extremely valuable as technology advanced rapidly and new war scenarios reflecting real world experiences were instructional necessities.[552]

In addition to coursework and the experiences that faculty brought to the program, students also benefitted from research opportunities available to support their thesis projects. Research sponsors often included Air Force officers, who directed students to specific research needs, opportunities, or topics that were intrinsically linked to a particular career path within engineering. This exposure offered students the opportunity to apply their educational experiences to real world issues, while providing specialized research and analysis for their sponsors.[553]

Civil engineers enrolled in programs at AFIT also were viewed as a valued workforce that required particular tools to complete specific tasks and fulfill future missions. In 2005, as the GWOT increasingly required experienced civil engineers, the CESS evaluated the curriculum to assess whether coursework was sufficient to address specific needs overseas. As a result, a two-week 41.5-hour course for junior civil engineers was created. Engineering 480: Simplified Facility Design provided civil engineers with the basics for building design. Topics included site selection, soil fundamentals, foundations, HVAC systems, electrical and mechanical systems, plumbing, roof designs, and fire protection. Each skill gained from the course was applicable in a variety of war scenarios and, in total, prepared junior civil engineers to contribute to construction and resource renovations on a larger scale. During this same time, the CESS created a field guide for pavements. The guide was available on CD, allowing civil engineers access to reference materials from any computer.[554]

Lessons learned from OEF and OIF were immediately utilized to boost technical training and educational opportunities for Air Force civil engineers. As a result, additional courses were created and others were expanded to enhance the CESS curriculum. Power system courses offered a combination of DVD-based training and in-residence coursework, providing students with hands-on opportunities and interactions with design and construction specialists. In addition, antiterrorism techniques and force protection measures were incorporated into design courses offered by CESS. Advanced educational opportunities on HVAC systems also were offered, enhancing the skills of personnel and allowing them to apply training to real world situations. Instructors teaching the courses were equipped with recent experiences during overseas deployments in Afghanistan and Iraq.[555]

In addition to offering curriculum that concentrated on needs identified during deployments overseas, AFIT also addressed the need for greater experience in a joint force environment. Work on the development of a Joint Engineer Operations Course (JEOC) began in 2005. Following three "pilot courses" and modifications, the first course officially was held at Fort Leonard Wood, Missouri, in 2007. The JEOC was conceived by personnel from all Services. A two-step course that included a distributed learning (dL) phase and a resident phase, enrollment was open to engineer officers as well as civilians employed by the government with joint staff responsibilities. The dL phase was planned as a 40-48 hour module available to engineers who desired increased proficiency in joint task force (JTF) operations. Students worked at their own pace, gaining up-to-date information. Participants were granted a dL certificate after completion of the first phase. The dL portion of the course equipped students with knowledge in seven areas: "national security strategy development; joint operations planning; joint engineer capabilities; JTF engineer staff operations and planning; theater engineer operations; joint engineering considerations and relations with joint interagency, intergovernmental, and multinational organizations; and, joint environmental considerations."[556] Although some students only completed this first phase, it was recommended that they also take advantage of the resident module to enhance their skills through completion of the entire course.[557]

Students enrolled in the resident portion of the course were required to have a dL certificate. The resident phase of the course included seminars and exercises, guest speakers, and teleconferences with specialists in the field. JTF scenarios were established and students were required to apply their comprehension of the JTF environment, providing appropriate solutions and suggestions to illustrate their intellectual capacity within a JTF operation. The discussion panels, lectures, and scenarios presented during the resident phase covered seven primary subjects: "service engineer capabilities; engineer support plan; JTF assignments, functions, and roles; horizontal staff integration; engineer functions; facilities engineering and general engineering; and outside-the-wire considerations." Additional topics were covered through guest speakers. AFIT CESS became a summer host of JEOC in 2008. [558]

In 2008, AFCESA and AFIT worked together to provide an extraordinary experience for students enrolled in the dL module of the JEOC. Through the efforts of AFIT instructor, Maj. Christopher Stoppel, students were granted the rare opportunity to participate in "webinars," video teleconferences with deployed civil engineers operating in a JTF. In some instances, participants discussed operations with the civil engineers whom they would be replacing during their next deployment. Students gained the latest feedback possible. They were exposed to the most current lessons learned from the field and were provided with accurate accounts of real life JTF operations. This innovative teaching method was intended to counter criticism that information previously presented was often out-of-date by the time civil engineers were in the field. The webinar program also benefitted AFIT, making possible revisions to the curriculum to reflect the most current activities and information from ongoing operations. AFCESA also saw the webinar program as a valuable resource for assessing previously identified and newly recognized lessons learned. The value of webinar extended beyond the JEOC classroom; the presentations were made available to engineers who benefitted from their content prior to deployment.[559]

By 2009, the JEOC was held at the U.S. Army Engineer School at Fort Leonard Wood, Missouri; the U.S. Navy Civil Engineer Corps Officer School at Port Hueneme, California; AFIT at Wright-Patterson AFB, Ohio; and, the Marine Corps University at Quantico, Virginia. In 2010, the JEOC opened a limited number of enrollment spaces to international engineers. The following year, the U.S. European Command held its own JEOC to enhance joint operations.[560] The course was beneficial for engineers throughout the Services, and internationally. It enhanced preparations for a JTF environment, arming personnel with the latest information and familiarizing them with the ongoing operations likely faced during the GWOT.

Another AFIT initiative was the Civil Engineer Superintendents Course, targeted to senior NCOs and civilian superintendents. CMSgt. Mike Doris, the Civil Engineering Chief of Enlisted Matters from 2000 to 2005 helped develop and advocate for the two-week course at a school normally reserved for officers and civilians. The course provided practical instruction in topics needed by senior NCOs who were being called upon to assume more and more responsibilities at the bases. A team of instructors presented topics such as personnel, resources, applied leadership, doctrine, Civil Engineer history, an overview of the FOAs, Air Staff and the various squadron flights to help round out individuals who had spent most of their careers in a single flight. The cross-functional networking and sharing of real world experience at the courses were also cited as benefits by the more than 100 students who attended each year.[561]

United States Air Force Academy (USAFA)

Similar to AFIT, the USAFA regularly revised the civil engineer curriculum to provide cadets with an education that included the most current information and lessons learned from ongoing operations. Creating accurate scenarios for students was a beneficial teaching tool that imparted lessons applicable during deployments. Courses presented opportunities for hands-on training. It also enabled students to work together solving problems and applying knowledge, preparing many of them for future roles as civil engineers.

The mission of USAFA's Department of Civil and Environmental Engineering remained to "build and maintain nationally accredited undergraduate civil and environmental engineering programs with a clear linkage to the operational Air Force as we produce leaders of character."[562] The Department's two majors, Civil Engineering and Environmental Engineering, were accredited by the Accreditation Board of Engineering and Technology (ABET). ABET accreditation was sought by undergraduate programs in engineering because it endorsed the curriculum and educational process of the program as fulfilling necessary requirements for graduating a student as an engineer. Accreditation ensured that the school's program provided students with the essentials necessary to enter the field of engineering on par with nationwide engineering standards.[563]

Cadets enrolled in either major were required to complete 91 hours of core curriculum covering engineering, humanities, basic science, and social science. In addition, they also completed 48 hours specific to a chosen major and five hours of physical education. ABET-required curriculum comprised four main themes or topics: structures, environmental, geotechnical, and construction. Along with conventional coursework associated with a general degree in engineering, students were exposed to a curriculum that provided information specific to Air Force programs. Opportunities offered by USAFA for in-depth study included summer courses geared toward actual Air Force activities associated with selected majors areas of concentration. By their junior year, cadets majoring in civil engineering or environmental engineering were prepared to enter the five-week summer session. The summer program was designed by the Department and included two modules, the Operation Civil Engineering Air Force (OPSCEAF) and the Field Engineering and Readiness Laboratory (FERL).[564]

Through the OPSCEAF module, cadets were paired with active squadrons for two weeks to work alongside personnel and understand the role of a civil engineer. They studied Air Force missions and operations, which allowed them to view firsthand the responsibilities and functions performed by a base-level civil engineer. The opportunity allowed cadets to experience many of the programs they had studied during their time at USAFA.[565] Additional weeks of work at USAFA's FERL followed completion of OPSCEAF. The FERL program included cadets from USAFA as well as the Reserve Officers' Training Corps. Cadets were involved in several "construct first, design later" projects, preparing them for the complex design curriculum completed during the junior and senior years at USAFA.[566]

Other programs offered by USAFA allowed students to complete research projects, participate in competitions, and take part in Department-sponsored chapters of professional engineer associations. These programs exposed students to representatives of major command, other civil and environmental engineering institutions, and professional groups, such as the Society of Civil Engineers, SAME, and the Society of Women Engineers.[567]

Civil and Environmental Engineering majors concluded their education at USAFA with a capstone course. This course provided the opportunity for students to work on the design and building phases of actual projects. Instructors played the role of owners, creating a scope of work and making schedule demands. Cadets worked with estimates and timetables, and were taught techniques for creating work plans and soliciting bids. The course concluded with a competition. Teams were created from the class, each representing a company bidding on a contract for an Air Force construction project. Teams created bids, prepared proposals, and presented their ideas to a panel for review. The competition was a week-long process that provided accurate scenarios designed to increase cadets' confidence in project management.[568]

Training

Training for military personnel became integrated in support of the concept "train like we fight." The combination of units with similar missions for training and the expanded initiatives for joint training were especially important to enhance the Air Expeditionary Force. In addition, lessons learned from the field were gathered rapidly, allowing training to be particularly tailored toward specific issues and needs. Learning new techniques, contributing to a variety of joint environments, and participating in lifelike scenarios were beneficial training experiences for all personnel involved. Training was not merely considered a way for civil engineers to freshen their skills; it was a critical part of preparing them for deployments in support of the GWOT.

Utility Systems Training

One aspect of civil engineer training was impacted during the early years of the twenty-first century due to the DoD directive to privatize on-base utilities. In the past, Air Force civil engineers were accountable for sustaining water, sewage, electric, and gas facilities on base. This responsibility provided an important training opportunity and allowed civil engineers to acquire and practice techniques associated with installation, repair, and maintenance of utility systems. In a 2001 interview, CMSgt. Michael F. Doris, who served as Chief of Enlisted Matters in the Office of the Civil Engineer, discussed the topic of utility privatization. Chief Doris pointed out that "utilities privatization will *not* result in lost opportunities for training our folks unless we let it." He encouraged the use of private utility companies and other venues to address training needs.[569]

In 2001, the civil engineer community teamed up with private utility companies to continue established training practices. The choice was logical since both Air Force and private sector training were grounded in the National Electric Code. The AFSPC led the program and began testing training with Colorado Springs Utility. One advantage to the new training partnership was a dedicated "Pole Farm," maintained by the utility that allowed a variety of training opportunities to Air Force civil engineers. The training facility offered modern equipment and was organized and operated by master electricians. In addition to the partnership with Colorado Springs Utility, other alternatives to address utility training were offered through the publication, *A Commander's Procedural Guide: Obtaining Training in Support of EAF and Utilities Privatization*. The publication was the initiative of AFCESA, which coordinated with representatives from major commands and training programs to assemble a directory of sources and strategies to address potential instructional alternatives.[570] The privatization of utilities affected the opportunities for Air Force civil engineers to train not only for on-base operations but also for overseas deployments. The quick response to this training need and the solutions identified allowed the civil engineers to continue their efforts without losing valuable instruction time.

Silver Flag Exercise Site

The Silver Flag Exercise Sites at Tyndall AFB, Florida, Kadena AB, Japan, and Ramstein AB, Germany, continued to provide contingency training through the first decade of the twenty-first century, promoting realistic situations and exposing personnel to newly advanced equipment. Resources at the site were not on hand at most other training venues, making Silver Flag a rare and necessary training facility. Training was available for active duty military, reservists, and ANG personnel; it incorporated lifelike scenarios to test competence and enhance skills. Runway repair, EOD, firefighting situations, and rescue scenarios were simulated and units worked together to solve problems and create innovative solutions to new experiences. Some civil engineers were trained in areas not typically assigned to their role in order to address actual needs in the field. The Silver Flag Exercise Sites also provided essential training with beddown assets.[571]

The Silver Flag site increased training initiatives during the first decade of the twenty-first century. Rather than providing training for key personnel to share with their units during home station training, Silver Flag began accommodating entire teams comprising a unit type code. This allowed for better coverage of personnel, especially considering that home station training facilities did not have access to the equipment available at Silver Flag. This followed the mentality of "train like we fight," training of an entire unit that would eventually deploy together as a team.[572]

Readiness Challenges

Readiness Challenge VII, postponed from 1999, was held in May 2000 and featured 16 teams of Civil Engineer, Services and Chaplain Service personnel from nine Air Force major commands, two direct reporting units, the Air National Guard and four foreign countries competing in 21 competitive

Air Force Materiel Command firefighters participate in the Search and Rescue event at RC VII.

events at the Silver Flag Exercise Site, Tyndall Air Force Base, Florida. The competition had the largest international participation with teams from Canada, United Kingdom, Norway, and Japan. Observers also came from France, Greece, Israel, Italy and the Republic of Korea. In the end, the team from Air Force Space Command received the Brig. Gen. William T. Meredith Trophy as the overall winner from Air Force Chief of Staff Gen. Michael E. Ryan. Readiness Challenge VII was the last competition to be held. Activities in support of ONE, OEF, and OIF impacted the Air Force's ability to hold Readiness Challenges. The 2001 competition was postponed and eventually cancelled. Readiness Challenge VIII was planned for April 2002 at the Silver Flag Exercise Site, with the theme "Expeditionary Excellence." An increase in international participation was anticipated and teams from Personnel Supporting Contingency Operations were slated to attend. At the end of 2001, Readiness Challenge VIII was officially called off for 2002. Col. Bruce Barthold, commander of AFCESA explained,

> while we regret canceling the competition, the main focus of all our fighting forces is the current and future support of activities related to Operations Enduring Freedom and Noble Eagle…in addition, the increased operational tempo being experienced now and into the foreseeable future makes it uncertain whether appropriate personnel and resources will be available to support the competition next spring.

Subsequent Readiness Challenges were also cancelled.[573]

Air Education and Training Command, 366th Training Squadron, Detachment 7

The Interservice Training Review Organization (ITRO) and the Base Realignment and Closure Commission sponsored an initiative to bring units with comparable missions from all service branches together at Fort Leonard Wood. The idea was viewed as being financially beneficial; the reorganization and relocations plan was also advantageous for training. Detachment 7 of the 366th Training Squadron, AETC, originally located at Sheppard Air Force Base, Texas, relocated to Fort Leonard Wood, Missouri, as part of the reorganization. In 1998, Detachment 7 of the 366th Training Squadron gained control of an Army training area at Fort Leonard Wood and began using the site to instruct students. It was soon evident that new buildings and training resources were needed in order to accommodate students and instructional areas. As a result, plans began for a new Pavements and Construction Equipment Operator Training Course. The $1.6 million facility was sponsored by AETC, AFCESA, ACC, AMC, USAFE, PACAF, AFSOC, and AFSPC. It took three years to complete construction. Facilities created as part of the project included classroom areas constructed by the 820th RED HORSE. The rooms were more than twice the size of the site's previous spaces and included environmental controls. The 819th RED HORSE erected a maintenance building and upgraded the water system. The 823th RED HORSE and the 307th RED HORSE worked side by side, erecting an 80 x 200-foot K-Span facility to accommodate sheltered training with heavy machinery. The new complex was officially opened on September 11, 2001. Although the new training facility was considered a huge accomplishment, the opening ceremony was not held because of the incidents of September 11, 2001. The construction of the new complex provided an opportunity for teams to work together, offering additional preparation for the new deployments they faced for OEF.[574]

By the following year, Detachment 7 of the AETC 366th Training Squadron was the largest training detachment within AETC. It supported training for Air Force civil engineers and ITRO providing instructions for the Air Force, Army, Navy, and Marine Corps using the new Pavements and Construction Equipment Operator Training Complex at Fort Leonard Wood. Its 70-day apprentice course was the longest course offered by any Air Force technical training school at Fort Leonard Wood. A second ITRO training school was Air Force Engineering, teaching four courses such as Engineering Design and Construction Surveying. The Air Force Civil Engineer Readiness School offered courses in disaster response and organized training for Prime BEEF personnel. Courses provided by the Readiness School included a 53-day, three-level Readiness Apprentice Course; a 10-day, seven level Readiness Craftsman Course; a 5-day Advanced Readiness Course; a 5-day mobile Air-Base Operability course; and a 5-day resident and mobile Nuclear/Biological/Chemical Control Cell Course. The entire series of courses offered by the Air Force at Fort Leonard Wood made the installation one of the premier locations for joint training programs.[575]

Eagle Flag

A new flag exercise, Eagle Flag, was introduced in 2003. The goal of the exercise was to assess and train expeditionary Air Force combat support personnel. Eagle Flag was established and organized by the Air Mobility Warfare Center's 421st Training Squadron located at Fort Dix, New Jersey. In a 2003 interview Brig. Gen. Del Eulberg explained,

> Eagle Flag is a new integrated training program for key and essential expeditionary combat support leaders…this training will not duplicate skills proficiency training we receive at home station and at Silver Flag. The training will focus on the integration required to support the initial force modules: open the airfield, set up command and control, and establish the air base. The idea is to ensure we incorporate "Lessons Learned" in OEF and OIF into our training plan. We want our warriors ready to deploy anywhere in the world in support of any mission after they finish at Eagle Flag. They will know what each functional brings to the fight and won't have to learn it on day one of the war.[576]

The first Eagle Flag was held in Lakehurst, New Jersey at the Naval Air Engineering Station. Each of the three main modules mentioned by General Eulberg, "open the airfield, set up command and control, and establish the air base," influenced key training activities. Participants practiced and enhanced their skills in preparation for their contributions to combat support during the GWOT.[577]

RED HORSE Troop Training

RED HORSE personnel were continually training to maintain their high levels of expertise while not deployed. They especially continued to gear up for future deployments in support of the GWOT. A stateside RED HORSE Troop Training program allowed personnel to enhance their skills for overseas deployments while also providing needed construction and repairs at Air Combat Command bases across the United States. The $12 million program allowed RED HORSE teams to complete ramp and runway construction and repairs, drill wells, and build support facilities. In 2007 as part of the Troop Training program, RED HORSE teams at Whiteman AFB, Missouri, identified and replaced portions of a runway and taxiway to maintain B-2 operations at the base. The 823d RED HORSE Squadron worked at the base for two months coordinating with the 509th CES. B-2 operations did not stop during the construction and replacement phases of the project. Once the teams finished the project, they returned to their home station at Hurlburt Field and continued gearing up for a planned deployment. The Troop Training program was beneficial to RED HORSE troops because it prepared them for the grueling pace and severe weather they would experience overseas, but it also gave them more confidence to handle large projects and work as a team.[578]

EOD Training

Standard EOD training continued to take place at the joint EOD training complex at Eglin AFB, Florida. The EOD training curriculum continued to be revised throughout the decade to meet the challenging and changing needs of overseas deployments. A1C Travis Eygabroad recalled his training, "The tech school is supposed to be 27 weeks but with all of the stuff there is to learn and with all of the tests, people usually plan on [more than that]…. We had 16 hour days at tech school; now that I am here [in Iraq], I am going through upgrade training."[579] In 2010, EOD training emphasized its nuclear mission. The AFI 32-3001, *Explosive Ordnance Disposal (EOD) Program,* was revised to reflect new training standards. New technical courses included a computer-based nuclear training module and several joint service courses: Advanced Improvised Explosive Device (IED) Defeat Course, Joint Nuclear Explosive Ordnance Disposal Course, Joint IED Improvised Nuclear and Radiological Dispersal Device Recognition Course, and Air Force Improvised Explosive and Nuclear Enhancement Course.[580]

In 2009, Air Force EOD pre-deployment training was reorganized into the Combat Battlefield Ready Airman (CoBRA) course held at the Tyndall Silver Flag Exercise Site. Previously, EOD training was provided by the Army in two courses that took 32 days. The Air Force took control of Air Force EOD personnel training to streamline the process and create more specifically targeted instruction. Teams were grouped to replicate how they would be organized within their deployments. EOD personnel met at CoBRA training and began building team cohesion before their deployment to the AOR. Instructors also incorporated elements specific to their planned AOR and deployment location into the 20-day CoBRA course. Instructors also stayed in contact with deployed personnel to maintain currency in the fast-changing battle against improvised-explosive devices. The course included tactics, life saving techniques, IEDs, target firing, communications, and combat situations. Training EOD personnel within their deployment teams built stronger solidarity and allowed troops to adjust easier and quicker when deployed. After completing training, teams knew they could work together and rely on one another in the actual warzone.[581]

Air Reserve Component (ARC) Training

ARC training was conducted at Regional Training Sites (RTSs) and Regional Equipment Operator Training Site (REOTS). In 2005, RTSs operated in North Dakota, North Carolina, Arkansas, California, and Pennsylvania. Use of the sites was not limited to ANG personnel; Air Force Reserve and active duty personnel also used the facilities. Primary training at RTSs included airfield damage repair, mobile power plant, mobile aircraft arresting system, emergency airfield lighting system, reverse osmosis water purification unit, power poles set, wartime operations training, field training requirements, global positioning systems, expeditionary GeoBase, and 15-ton mobile crane operations. The ANG REOTS occupied 20,000 acres at Fort Indiantown Gap in Pennsylvania and the AFRC operated a REOTS at Dobbins Air Reserve Base, Georgia. The sites accommodated hands-on operating instruction in graders, bulldozers, excavators, and front-end loaders. ANG and Air Force Reserve heavy equipment operators were required to train at the REOTS every three years. While REOTS training was not mandatory for active duty civil engineers, many were attracted by the opportunity for pragmatic and hands-on instruction.[582]

DEPLOYMENTS

Introduction

Throughout the first decade of the twenty-first century, Air Force civil engineers continued to work closely with the other U.S. Armed Services and with their counterparts in other countries. Coordination occurred during contingency operations and through participation in Joint Task Forces. Working cooperation, or jointness, was an underlying premise of the 2001 QDR. General Fox characterized the Air Force:

> We are a purple suit organization. We enhance each other's capabilities. The Army can't do its job without us. We help get them to the fight, we help supply them once they're in the fight, we provide close air support for them, and we provide a lot of the air platform intelligence, like early warning systems. We also work closely with the Navy. Some Navy missions interface with Air Force missions, and I think we do that better than we ever have. In the civil engineer arena, we clearly complement each other's capabilities.[583]

Joint operations within a particular AOR required stringent management and a defined organizational structure. Joint operations far exceeded simply assigning U.S. Armed Service personnel to perform the same task; planning, organization, communication, and logistics were essential. Joint Task Force (JTF) headquarters were created to orchestrate individual operations. Engineer personnel played a key role within the JTF environment and were charged to: "establish JTF engineering policy and guidance; exercise staff responsibility for facilities, real estate, design and construction, real property maintenance and environmental management; and, forecast and monitor the flow of engineer resources (people, equipment and supplies) in the Joint Operations Area (JOA)." Executing these responsibilities often required the creation of Joint Civil-Military Engineering Boards, which were tasked with creating procedural guidance for civil-military engineering activities within a particular JOA. A firm grasp on the competence and qualifications of involved units was necessary. JTF engineer staff also assessed equipment and resources and monitored pending projects within the JOA.[584]

Efforts to achieve more effective joint operations led to formal and informal interactions between civil engineers from each U.S. Armed Service and the civilian professional community. In 2004, AFCESA and SAME sponsored the first Civil Engineer Joint Senior NCO Symposium at Tyndall AFB, Florida. Personnel from the Air Force, Army, Navy, and Marine Corps participated in the gathering. The primary goal of the symposium was to assemble senior NCOs and contractors to address specific civil engineer lessons learned during OEF. The meeting provided an excellent opportunity for civil engineers from each U.S. Armed Service to discuss their experiences and expand their knowledge of civil engineering roles throughout the entire U.S. military.[585]

The Joint Operational Engineering Board (JOEB) worked as an advisory/proponent group comprised of senior engineers from all combatant commands and U.S. Armed Services. Engineers from all U.S. Armed Services participated in four working groups: Doctrine/Training, Interoperability, Transformation, and Capabilities.[586] The board conducted discussions on common engineering requirements for all U.S. Armed Services. Typically, The Civil Engineer chaired one committee on the board. General Eulberg, for example, chaired the Interoperability group. He reported progress on standardizing engineering expeditionary construction equipment across all U.S. Armed Services. Such standardization in combat areas helped assure proficient equipment operation by engineers across the U.S. Armed Services.[587]

Another area where jointness was vital was formulating cross-Service standards, criteria, guidelines, and operability for engineers. One area of standardization among the U.S. Armed Services was the formulation of technical criteria for design and construction. The Tri-Service Committee for Unified Design Guidance reviewed the design and construction standards of all U.S. Armed Services to establish single unified guidance. It was a multi-year project. As of 2000, less than 20 percent of the technical criteria had been unified. By 2011, it had reached 70 percent.[588]

While Air Force civil engineers illustrated their capabilities within the joint environment, they also were determined to maintain their core competencies in contingency operations. General Fox was adamant that Airmen supported airfields. Airmen were specifically trained to work on and around airfields. They had expertise to operate and maintain specialized equipment, such as airfield lighting systems, power production, and generator support for airfield lighting operations. Airmen were trained on airfield safety clearances, crash rescue, and Air Force munitions. General Fox stated,

The doctrine is in place. It says Airmen are best qualified to operate airfields. Where we disconnect is when we have an Army installation in a contingency environment that just happens to have a large runway on it. My view is, if the Army wants to support the cantonment area, that's fine. But if the Air Force is going to fly airlift or tanker missions in and out of there, or if fighters are going to frequent that airfield, then the Air Force ought to be manning that airfield, because we operate differently in our airfield environments. It's roles and missions, but it's also expertise.[589]

Joint Publication 3-34: *Joint Engineer Operations* doctrine published in 2007, described the specialized role of the Air Force Engineer. In 2011, civil engineers worked with the Curtis E. LeMay Center to once again publish their own separate doctrine, *3-34 Engineer Operations*.[590]

Aerospace Expeditionary Force (AEF) Personnel Deployment Challenges

Deployments under the Aerospace Expeditionary Force (AEF) structure were integrated into the working operations of Air Force civil engineers during the first years of the twenty-first century to support ongoing missions such as Operations Northern Watch and Southern Watch. The AEF deployment cycle was a way to supply continuing rotations of military personnel to combatant commanders. The typical AEF cycle was fifteen months. Military personnel were assigned to one of ten standing AEFs. Personnel associated with two AEFs were available for deployment during specific 90-day periods when the AEFs were "in the bucket." The first AEF cycle began on October 1, 1999; the second AEF began in January 2001. The implementation of the AEF structure fostered regularity in personnel deployments and enabled agile and flexible responses to contingency situations.[591] The Air Force civil engineer component of the two AEFs numbered approximately 1,800 engineers and included traditional engineering, fire protection, and EOD personnel. An additional 700 Air Force civil engineers with specialized expertise were on-call during each 90-day AEF rotation. These experts were assigned from RED HORSE units, CEMIRT, or other specialty teams. Approximately 10 percent of this force was drawn from the ARC comprising the ANG and the Air Force Reserve.[592] Integrating the ARC civil engineers fully into the AEF schedule was a challenge during the first two AEF cycles; by the third cycle, full integration was complete.[593] Typically, 1,500 active, ANG, and Reserve civil engineers were deployed monthly around the world during the first AEF.[594]

Implementation of AEF required restructuring of the civil engineering UTCs. Existing lead team and follow-on teams were too large for typical mission requirements. Smaller teams were needed. For example, firefighter UTCs were adjusted to six firefighters, which matched the number of personnel required to operate a fire vehicle. The equipment UTC packages were similarly reconfigured.[595] The new UTC list afforded greater options in both team size and equipment packages, resulting in smaller, modular UTCs comprising personnel with tailored skill sets and experience levels to meet a variety of contingency requirements. "Operational expeditionary changes also dictate we use innovative approaches and new technologies to continue making our teams lighter, leaner and more rapidly deployable and employable," wrote General Robbins.[596]

The restructured UTCs allowed more Airmen to be assigned to AEF units. When the second AEF cycle began in January 2001, 114,000 Air Force personnel, or approximately one-third of the total force, were assigned to AEFs. During the third AEF cycle, the number rose to 173,000 of the 272,000 total AEF deployable Airmen. One goal of then Air Force Chief of Staff Gen. John Jumper was to assign every Airman to an AEF and for each Airman to understand that he or she was part of an expeditionary air force.[597]

Before the end of the second AEF, the attacks of September 11, 2001 spurred Air Force civil engineers to undertake a totally different kind of war, the GWOT, in addition to meeting ongoing mission requirements. GWOT was a crisis of unknown intensity and duration. Immediately, the numbers of deployed Air Force civil engineers doubled to meet an increasing number of mission requirements as the U.S. military focused on homeland security and Afghanistan.[598] During fall and winter 2001, 2,000 Air Force civil engineers deployed as part of OEF, in addition to the 500 already deployed as part of ongoing, "steady state" commitments of Operations NORTHERN WATCH and SOUTHERN WATCH.[599] During 2002, approximately 1,900 civil engineers were deployed to support OEF.[600]

Personnel were drawn from additional AEFs to meet the increased requirements and deployments began to be extended beyond the normal 90 days. By July 2002, ten percent of Air Force personnel were deployed on tours longer than 90 days. The USCENTCOM sought to increase the tour duty to 179 days to foster cohesion among forces in the combat zone. In 2004, the Air Force AEF deployment schedule officially was changed to 120 days within a 20 month cycle to support OEF and OIF.[601]

Deployment strategies were complicated further by the fact that some forces with unique capabilities were not assigned to a regular AEF library, but to an "Enabler Library." These specialized personnel, such as EOD, were not necessarily deployed within the regular AEF cycle guidelines and operated under an "alternative battle rhythm."[602] Air Force civil engineers also were deployed in individual augmentation (IA) and "in lieu of" (ILO) taskings to the U.S. Army. IA assignments typically followed the AEF cycle, but, by 2007, deployments of 179 or 365 days became typical. ILO assignments to the U.S. Army, begun in 2004, also resulted in deployments extending 179 or 365 days.[603] These longer deployment periods typically affected those personnel in expeditionary combat support career fields, such as civil engineer, EOD, and firefighters. In 2005, 855 Airmen were on ILO assignment to the U.S. Army; the number reached 1,119 by 2006. In these deployments, Airmen completed combat skills training to ensure that they could open, operate, and sustain facilities within base perimeters, as well as operate in a hostile combat environment "outside the fence."[604]

Demand for particular skill sets taxed some civil engineer career fields, in particular firefighting, EOD, power production, and readiness. Manpower shortages in these and other career fields in the AEFs required the activation of stop-loss rules, which froze retirements and postponed release dates for active duty personnel. One measure for relieving the shortage in certain career fields was to expand the manpower pool by assigning all military civil engineers to deployable UTCs for AEF assignment. Short-term measures were used to address the immediate personnel shortfalls, since a long-term solution to increase the number of permanent personnel required authorization from the Air Force Manpower and Innovation Agency.[605] The effects of more frequent and longer-term deployments were monitored by The Civil Engineer.[606]

During 2007, the UTCs were revised again to allow greater flexibility. The previous set of UTCs anticipated beddown operations, building bases, waging war, and removing and reconstituting assets. By 2007, most taskings were related to sustainment operations and non-traditional taskings, such as service with joint missions. The UTCs were refined to reflect evolving specific mission requirements in numbers of personnel and appropriate skill sets. The integrated process team charged with transforming the UTCs established the following goals:

- Develop a modular Prime BEEF UTC construct to provide Air Force and joint base operating support, and to augment RED HORSE when needed;
- Reduce UTC tailoring for sustainment operations, and reduce personnel not postured on a standard UTC;
- Minimize cross-training impact on the Air Reserve Component and ensure career progression within UTCs; and,
- Provide a flexible engineer force to Combatant Commanders (COCOMs).[607]

Reconfiguring the personnel UTCs required commensurate adjustment to equipment UTCs. AFCESA undertook the development of the equipment repackaging guidelines. The revised UTC codes were implemented in January 2008.[608]

Deployment pressure on Air Force civil engineer personnel continued to increase throughout the decade. A surge in deployments accompanied the U.S. military attention on Iraq during fall and winter 2002 in preparation for the March 2003 OIF. At the peak of operations, the Air Force deployed over 4,500 active duty, ANG, and Reserve civil engineers. Air Force civil engineers established and maintained 38 bases and extended $445 million in contingency MILCON funds.[609] By 2004, approximately 2,500 Air Force civil engineers were deployed to maintain 16 bases and selected Army camps.[610] By 2008, more than 3,000 Air Force civil engineers were deployed in support of the GWOT, OIF, and OEF.[611] In 2010, 4,000 Air Force civil engineers were deployed; 60 percent supported joint and coalition teams.[612]

Contingency Deployments

Following the attack on the World Trade Center on September 11, 2001, Air Force civil engineers immediately supported response operations in CONUS and in oversea areas of responsibility. Major activities executed by Air Force civil engineers included bed down for troops and aircraft. Force protection measures were at the forefront of overseas beddown activities. Perimeter security was a major priority. Air Force civil engineers typically installed fences, concertina wire, perimeter lighting, and constructed berms, ditches, and barriers. Areas outside of the perimeter were cleared and maintained to provide a clear zone of visibility. In addition, Air Force civil engineers established and maintained secure and continuous primary and secondary power sources.[613]

EOD and firefighters also were in demand. EOD flights provided myriad services to the Air Force and Joint Service operations ranging from to aircraft munitions response to unexploded ordnance and IED removal. Fire protection personnel were active at every installation and bare base with an Air Force presence in the theater. In addition to standing ready for hot pit refueling and responding to fire alarms, firefighters trained host nation civilians and military personnel, and responded to calls outside base perimeters.[614]

Post-September 11, 2001 - the Immediate Aftermath

Air Force civil engineers were tasked with immediate rescue, fire, and logistics support in the aftermath of September 11, 2001. At the World Trade Center site, Ground Zero in New York City, civil engineers contributed to rescue efforts and organized equipment stations. Civil engineers worked with the New York City Mayor's Office of Emergency Management. At the governor's request, approximately 150 ANG fire service and Prime BEEF personnel reported to the scene from New York's five Air National Guard civil engineer squadrons: the 105th CES, Stewart ANGB, Newburgh; the 106th CES, Francis S. Gabreski Airport, Westhampton Beach; the 107th CES, Niagara Falls; the 109th CES, Stratton AGB, Scotia; and, the 174th CES, Syracuse. Civil engineer squadrons also responded with critical engineering and logistics support. According to Maj. Earl Evans, 174th Fighter Wing Base Civil Engineer, "we worked with the New York Housing Authority in distributing and controlling items such as small generators and government trucks. We assisted the Army National Guard in setting up a sort of central warehouse facility, collecting stock from drop off points all over the city, setting it up, cataloging and distributing it." Air Force civil engineers also were a source of expertise on rapid decontamination methods for personnel working at Ground Zero.[615]

ANG teams worked alongside Army National Guard personnel to enhance force protection. Guard members from the Air Force and Army initially were bedded down in armories and other locations throughout the city. The civil engineers were tasked with finding alternate locations for troop billets. They contacted the Coast Guard to use the facilities at Governor's Island located in the harbor. The Coast Guard had suspended operations on the island in 1997, but several apartment buildings remaining on the site offered the potential for housing personnel. A Prime BEEF team was formed from New York ANG personnel; they re-opened apartment buildings and a dining hall on the island for troops working in New York. Eight firefighters joined the small existing fire crew at Governor's Island to provide fire protection for the newly reopened site.[616]

At the site of the Pentagon attack, then-Col. Timothy A. Byers, Chief of the Readiness Division for The Civil Engineer set up a civil engineering command post within hours of the attack. Maj. Gen. Earnest O. Robbins, II, The Civil Engineer, was stranded in Missouri at a dedication ceremony for a new training facility at Ft. Leonard Wood. Colonel Byers was fortunate to have several members of his staff such as Mr. Dick Pinto who had worked the Tactical Air Command battle staff throughout the Gulf War and had worked contingency issues for years, and Lt. Col. Greg Cummings, who had worked readiness issues at AFCESA. In addition to ensuring the Total Force engineers were postured and ready to respond where needed, the group worked initial beddown planning for Air Force weapons systems and personnel using GeoReach. They also began to work the protection for installations within the CONUS, and a renewed emphasis on chemical, biological, radiological, nuclear, and high explosive issues.

In addition to rapidly responding to the New York tragedy, Air Force civil engineers were assigned several responsibilities associated with strengthening U.S. defenses. Air Force civil engineers with the fighter wings of the First Air Force supported combat air patrols over cities and critical areas across the United States under Operation Noble Eagle. On-base civil engineer assignments included force protection, EOD and power production. Power production specialists operated aircraft arresting barriers to support sortie missions on bases across the country.[617]

In the immediate aftermath of the September 11, 2001 terrorist attacks, Air Force civil engineers performed quickly and efficiently during a most challenging event in U.S. history. Maj. Jesus Figueroa, commander of the 106th CES at Ground Zero, reflected, "especially because it was in our homeland, there was a lot of stress and what we call combat fatigue, even though we weren't in combat. The adrenalin and the tension were so high that people didn't sleep well. There were a lot of obstacles to overcome, but we did our best."[618]

The September 11, 2001 terrorist attacks were a singular blow with far reaching human and psychological effects upon the United States apart from the destruction and significant loss of life. Air Force civil engineers were highly trained military personnel, but also U.S. citizens who directly witnessed the tragedy. They demonstrated dedication to the defense of country and compassion as citizens. SSgt. Tyree Bacon, who served with the 514th CES in New Jersey, was on duty as a civilian officer for the New York State Supreme Court in Manhattan when the first tower was struck. He and nine co-workers quickly responded at the scene to offer assistance. SSgt. Bacon, who was trained as an EMT, entered Building 5 and was rescuing a burn victim when the first tower collapsed. When he emerged from Building 5, the environment of his hometown and the nation was completely changed. SSgt. Bacon articulated his experience months later, "I've never experienced war before in my life, but I've seen hell."[619]

Operation Noble Eagle

Operation Noble Eagle (ONE) was established after the September 11, 2001 terrorist attacks. This operation ensured national security through round-the-clock combat air patrols (CAP). Initially, the Navy and Marine Corps were involved in the operation; it was quickly designated an Air Force mission. The operation utilized the North American Aerospace Defense Command's radar system and data from the Federal Aviation Administration. Immediately following the September 11, 2001 attacks, Air Force civil engineers with the fighter wings of the First Air Force were called to support CAPs over cities and critical areas across the United States. CAP sorties in CONUS outnumbered those in the Middle East during fall 2001. Over 500 Air Force civil engineers were supporting ONE by the winter of 2001.[620]

Eventually, ONE shifted to ready alert aircraft crews. This decision was made to relieve overextended pilots and crews that had supported the 24/7 operation. Using the ready alert system also was less expensive. ONE cost an estimated $200 million per month using continuous CAPs. At the time of the terrorist attacks, the Air Force had seven sites with ready alert capabilities; this number was increased to 18 by 2004. During ONE, the Air Force retained at least 35 fighter aircraft, eight fuel tankers, and two E-3 Airborne Warning and Control System aircraft on ready alert. Within two years of the attack, the Air Force completed over 32,000 sorties for ONE.[621]

Operation Enduring Freedom

Air Force civil engineers faced numerous challenges during Operation Enduring Freedom (OEF). The focus of this operation was seeking out Osama bin Laden, the infamous leader of Al Qaeda, and the Al Qaeda terrorist training camps operating in Afghanistan, a mountainous country with a challenging physical environment. In addition, the immediacy of the operation left little time to build up forces and establish forward bases between the September 11, 2001 attacks and the first air strikes on Al Qaeda and Taliban airfields on October 7, 2001.

Army Gen. Tommy R. Franks served as USCENTCOM chief. U.S. Central Command Air Forces (USCENTAF) was represented by the Combined Forces Air Component Commander, Lt. Gen. Charles F. Wald. USCENTAF established a Combined Air Operations Center (CAOC) at Prince Sultan AB, Saudi Arabia.[622] In February 2002, USCENTAF established a separate civil engineer staff function led by Col. Tom Ryburn, chief, Readiness Division, Directorate of The Civil Engineer, Headquarters, Air Combat Command (ACC), who deployed from Langley AFB, Virginia.[623] This organization was similar to the command structure used during Operations Desert Shield/Desert Storm. ACC, through the Civil Engineer Directorate's Contingency Readiness Center, provided planning support and AFCESA supplied expertise in airfield pavements and other areas, as required.[624]

Brig. Gen. Patrick A. Burns, who served as the ACC Civil Engineer during OEF, described the environment as "a whole new ball of wax" in comparison to the conditions encountered during Operations Desert Shield/Desert Storm. Afghanistan and its neighboring countries were mountainous, arid lands that required troops to adapt to both blistering sun and severe cold. In addition to the challenging climate and terrain, the water supply in many isolated areas was either unavailable or extremely limited.[625] General Burns provided a good description of what Air Force personnel faced during OEF:

> our engineers, as well as those of the other Services, faced some of the most austere "bare base" environments in the "stans" we've ever encountered. Things like worn out airfield pavements, no utilities whatsoever, and no sources of equipment or supplies within hundreds of miles. When you couple that with the typical iron flow arriving before the combat support forces as I mentioned earlier, the first 30 days at those sites were challenging to say the least.[626]

Two types of bases were utilized during the initial deployments, both were challenging. Bases on the Arabian Peninsula had adequate runways but little room for bedding down troops, parking, or fuel supply. Other bases, located within the "stans," were out-of-date or partially destroyed and offered little opportunity for development. Bases in the Arabian Peninsula included Al Udeid AB in Qatar, Masirah AB in Oman, and Al Dhafra AB in UAE. Bases located within the "stans" comprised Shahbaz AB in Pakistan, Khanabad AB in Uzbekistan, Manas AB in Kyrgyzstan, and Bagram AB and Kandahar AB in Afghanistan.[627]

The United States identified two significant issues during the initial planning for the war in Afghanistan: Afghanistan was a landlocked country and the United States held no bases near its borders. Pakistan President Pervez Musharraf agreed to provide the United States with access to bases in Pakistan; the principal base was Shahbaz AB in Jacobabad near the border with India. As in the case of Operations Desert Shield/Desert Storm, support personnel arrived at the base after the aircraft and crews. Air Force Special Operations Forces (SOF) were housed in a hangar and using an outdated septic system when the first Air Force civil engineers arrived in late October 2001. Sewage leaked through the vents of the makeshift latrine posing a health risk and attracting disease-carrying mosquitoes. Personnel became ill due to contaminated water. A RED HORSE member specializing in water facilities quickly corrected the water quality problem by equipping the site with a chlorination system and installed a Reverse Osmosis Water Purification Unit.[628]

During the initial establishment of beddown sites in Pakistan, personnel faced the differences between American and Pakistani culture, lack of access to technology, and a lack of experienced and efficient local labor. The Air Force depended on local contractors for selected materials and labor, particularly during the preliminary stages of establishing sites for troops. Local sources were often inadequate. At Shahbaz AB, for example, installation of Harvest Falcon kits in a former rice field required a two foot increase in the site elevation for adequate drainage. Civil engineer Maj. Jeff Perham determined that this grade change required 1,200 truckloads of gravel. Local labor was requested and within a matter of days the American Embassy in Islamabad secured a contract for the work. Expecting to receive several truckloads of fill, Major Perham was surprised when one colorful truck without dumping capacity arrived accompanied by two men. The truck was unloaded by hand using shovels. Manual labor continued for several days. Attempting to remedy the situation at Shahbaz, the United States rented supplementary equipment for the local contractors; however, Pakistani law prohibited use of the equipment and instead supported labor intensive approaches to employ the largest number of people possible. Major Perham recalled, "They said they were not allowed to be efficient; they had to be more concerned about employment." Eventually, gravel deliveries were increased and the beddown site at Shahbaz was completed.[629]

Pakistani local labor unload gravel using shovels.

Another site within the "stans" was Khanabad Air Base in Uzbekistan, later known as Karshi-Khanabad or K2. The base was strategic for U.S. military troops because of its location within 300 miles of Kabul, Afghanistan. Originally, the U.S. Army was tasked with providing base support; the majority of troops proposed for deployment to the site were Army personnel. Once OEF commenced, base responsibility was turned over to the 16th Special Operations Wing. A team of 55 Air Force civil engineers was formed with members from Hurlburt Field, Florida; Minot AFB, North Dakota; and, Eglin AFB, Florida. Similar to previous experiences, the aircraft and crews arrived prior to support personnel, forcing makeshift living arrangements and over-taxed septic systems. Once support personnel arrived, they faced the hurdle of organizing site work and people at the base. Often, unexpected planes arrived with unknown cargo. Lt. Col. Timothy Boone, who was the commander for the 16th CES from Hurlburt Field, explained the extent of the confusion, "we never knew day-to-day what was coming. It was just, 'go open the plane and see who comes out, what comes out, and then we'll react. Make sure we've got enough tents to cover them all.'"[630]

At K2, Air Force civil engineers utilized Harvest Eagle assets, as well as Army Force Provider beddown kits. The Army kits did not include items that the Air Force civil engineers considered necessary, such as fire extinguishers and heating devices. Colonel Boone clearly was pleased with the performances of the Air Force civil engineer teams at K2, "it was rough when we got there…a dust bowl with nothing, in the middle of nowhere. When we left, it was in good shape…we improved the quality of life for folks there."[631]

Near the end of 2001, the United States entered into an agreement with Kyrgyzstan to build a coalition air base at Manas International Airport near Bishkek in northern Kyrgyzstan. The airfield offered an up-to-date 13,800-foot runway, as well as modern taxiways, parking, and lighting capabilities. Weather at the site was harsh, with temperatures dipping below zero. Lt. Col. Kevin Rumsey, base civil engineer at Manas, recalled working in the cold environment, "it was freezing cold; it would

Members of the 376 Expeditionary Civil Engineer Squadron clear snow and ice from runways for aircraft at Ganci Air Base, Manas International Airport, Kyrgyzstan.

reach temperatures below zero frequently the first four weeks we were there. We were able to work through the challenges of freezing pipes and freezing boilers and diesel fuel that gelled and wouldn't flow through the heaters…to me, that's a major accomplishment. That's the most significant one. And we were able to do that, for the most part, within 30 days."[632]

At Manas, unlike other bases, support personnel arrived before the aircraft crews, in the form of the 86th Contingency Response Group from Ramstein AB. A handful of civil engineers in the group began planning for the tent city and utilities for the site. This schedule allowed for the establishment and rehabilitation of resources prior to the arrival of the majority of personnel. After establishing tents for occupancy, the support personnel at Manas used some of their "extra" time to create amenities such as a gymnasium, a post office, and a chapel. Air Force civil engineers also installed concrete floors within the tents, despite freezing temperatures. The U.S. troops christened the base Peter J. Ganci, Jr., Air Base, in honor of the chief of the New York City Fire Department who died during the rescue operations following the September 11, 2001 attacks.[633]

Other locations did not boast modern facilities comparable to those found at Manas. At Kandahar AB in Afghanistan, the existing 10,000-foot runway was constructed in 1960 by the U.S. Air Force to support reconnaissance missions over the former Soviet Union. The runway later was operated by the Soviet Union, but then abandoned. At the beginning of OEF, U.S. bombs nearly destroyed the airfield to prevent its use by enemy forces. When the U.S. coalition forces and the Northern Alliance acquired control of the majority of Afghanistan, Kandahar AB was identified as one of two bases for restoration. Army Forces Central Command was tasked with providing base operating support for Kandahar by USCENTCOM. Although Kandahar AB primarily was used by the U.S. Army, the Air Force provided support to the Army in some areas. In particular, Air Force EOD teams removed airfield ordnance. Air Force EOD personnel had access to the latest machinery, such as the All-Purpose Remote Transport System and a modified Hummer that supported Standoff Munitions Disruption.[634] Air Force firefighters provided services to the base and participated in joint training exercises with the host nation's military and international airport fire department.[635] Air Force civil engineers at Kandahar AB also undertook runway repairs. The runway at Kandahar was considered unstable and aircraft were breaking through the surface upon landing. Navy Seabee engineers, located at Kandahar, used compressed soil to remedy the damage, but this approach required daily upkeep. Eventually, Air Force civil engineers worked alongside Army engineers to renovate the runway.[636]

Other projects included repairs to the runway at Bagram AB in Afghanistan. At Bagram AB, the 200th RED HORSE Squadron from Camp Perry ANG Station, Ohio, and the 201st RED HORSE Flight from Fort Indiantown Gap, Pennsylvania, were called upon to repair a runway bombed by U.S. and Allied forces during the effort to drive the Taliban from Afghanistan. The runway repair was challenging for the civil engineer teams because it originally was constructed using Soviet Union construction practices. Soviet Runways were built using a concrete slab method, as opposed to the continuous pour concrete runways preferred by the United States. The slab technique was simpler to build, but harder to maintain. The joint seams between slabs made smooth surfaces problematic. Initially, 70 slabs were identified for repair. RED HORSE teams along with other Air Force civil engineers from four separate units arrived at Bagram AB with a deployable pavement repair system (DPRS), anticipating a task of about 45 days.[637]

When pavement evaluation teams completed the on-the-ground assessment at Bagram AB, the number of slabs requiring repairs rose to 504. Each slab measured approximately 11 by 13 feet; restoration required at least an hour per slab. Due to the increased scope of repairs, acquiring a concrete batch plant quickly became a priority. Procuring the plant took time but, in the meantime, the Air Force civil engineers pushed forward with the DPRS. Over 1,800 cubic yards of concrete were placed within the initial three months of repairs using DPRS. Lt. Col. Michael P. Skomrock, a member of the 200th RED HORSE Squadron involved in the project, remarked, "those who have used a DPRS will understand what a major undertaking that was." The DPRS was designed to accommodate relatively small amounts of concrete, but the three months of use at Bagram AB truly put the system to the test. In addition to the unusual quantity of concrete expected from the system, the DPRS struggled to adapt

The 200 RED HORSE Squadron and 201 RED HORSE Flight make repairs to the runway at Bagram AB, Afghanistan in 2002.

to the varying size of rocks utilized. These combined complications kept the equipment mechanics busy; weekly repairs for the system numbered between 60 and 70. The concrete batch plant arrived, bringing relief to all involved in the project. With the batch plant, it was possible to repair up to 38 slabs per day. Eventually, more than 600 slabs were repaired at Bagram, necessitating the use of 2,500 cubic yards of concrete. For security reasons, some of the work had to be completed after dark. This created yet another obstacle and required the use of night vision goggles (NVG). Although the use of NVG complicated operations, it also offered an excellent training opportunity. Colonel Skomrock used NVG at Bagram AB and offered this lesson learned: "lesson one is to spend a lot of time using the NVGs prior to doing a full repair...It's only after you start working in them that you realize how severe the loss of depth perception is…The viewpoint through NVGs is very different."[638]

In addition to runway repairs, Air Force civil engineers deployed to Bagram AB rebuilt Air Force Village, reinforced force protection fencing, constructed lavatory and laundry facilities, and assisted with the creation of a sports court.[639] The 200th/201st ERHS were instrumental in improving living conditions on the base. In May 2002, an Air Force civil engineer team traveled to Bagram AB to assess the quality of beddown resources provided for Air Force personnel and sustained by the U.S. Army. Air Force civil engineers discovered under-maintained tents in need of repair or replacement. They also noted that the tents were wired incorrectly and assembled too close to one another, thus presenting fire and safety hazards. In June, a team of 40 Air Force civil engineers was sent to Bagram to provide and erect TEMPER tents. They also provided materials for new electrical systems. Tent demolition and construction was completed in stages to avoid disrupting routine operations on the base. The U.S. Army Prime Power workforce assisted the Air Force civil engineers in the installation of the electric system. The tent area, fire house, and operation facilities were reconstructed within six weeks.[640]

During their 180-day deployment as part of OEF, the 200th/201st ERHS had deployed more than 350 personnel to 13 bases in 10 countries. Maj. William Giezie, a member of the 200th RED HORSE Squadron who served as operations officer for the 200th/201st during the deployment, summed up the accomplishments of the civil engineer teams:

> We executed over $14.5 million in construction material procurement and heavy equipment rental. We placed 10,000 cubic meters of concrete and 15,000 metric tons of asphalt, used 1 million gallons of construction water and consumed 100,000 metric tons of crushed aggregate. We deployed more than 50 C-17 loads of heavy equipment, materials and personnel from our headquarters at Al Udeid AB to our spoke locations throughout the AOR.[641]

Major Giezie's summary of tasks illustrated the sheer volume of work accomplished by the Air Force civil engineers. It also demonstrates the breadth of their abilities and the level of contribution made during the initial stages of OEF. The 200th/201st ERHS was the first ANG RED HORSE squadron to perform as a "full" RED HORSE squadron, instead of supporting or providing additional manpower to an active duty RED HORSE team.[642]

In addition to work in the "stans," Air Force civil engineers worked at bases on the Arabian Peninsula. Many of these bases were improved during Desert Shield/Desert Storm; however, the majority lacked facilities to support deployments during OEF. On September 30, 2001, members of the 366th CES from Mountain Home AFB, Idaho, along with a bare base team from Holloman AFB, New Mexico, reported to Al Udeid AB to provide fuel storage, a fuel pipeline, and build 150 tents and additional facilities. A major obstacle encountered in Qatar was base restrictions. U.S. forces were not allowed to choose their beddown locations on-base; this prohibition often meant that Air Force civil engineers graded sites only to have the host nation change the sites. In addition, strict security prohibited easy access to the base; security was particularly frustrating for ADVON teams who required frequent access to assess and prepare for follow-on teams.[643]

First Fatality of Operation Enduring Freedom

On October 10, 2001, MSgt. Evander E. Andrews with the 366th Civil Engineer Squadron died in a heavy equipment accident at Al Udeid AB, Qatar. He was the first American casualty of Operation ENDURING FREEDOM. Sergeant Andrews served 18 years with the Air Force. He was buried in Arlington National Cemetery on October 22. General Robbins remarked on the sacrifices of the civil engineers, "we are grateful for MSgt. Andrews, his service and the service of all the members of Air Force civil engineering. The nation is grateful, too." In honor of Sergeant Andrews, fellow troops named the tent city at Al Udeid AB, Qatar "Camp Andy" and a memorial was established at the Heavy Construction Equipment Operator School, Fort Leonard Wood, Missouri.[644]

To expand the airfield at Al Udeid Air Base in Qatar, the 820th RED HORSE Squadron from Nellis AFB, Nevada, and the 823d RED HORSE Squadron from Hurlburt Field, Florida, constructed a massive 15,000-foot long concrete parking ramp capable of accommodating flight line areas for more than 100 aircraft. The construction period spanned from November 2001 to April 2002. The MILCON project included taxiways and lighting and cost approximately $9.1 million to complete. The size of 18 football fields, this was the biggest assignment to-date for RED HORSE. More than 1,000 cubic yards of concrete were laid at the site per day, with 350 trucks delivering rock every 24 hours. Almost immediately after completion, Al Udeid AB supported approximately 24 KC-135 and K-10 fuel tankers. The Air Force civil engineer accomplishments at the airfield were noteworthy; the airfield made in-flight refueling possible for many of the aircraft fighters and bombers headed to Afghanistan. In addition to the aircraft ramp and associated facilities, RED HORSE also completed sheltered maintenance areas, hangars, and a fire station. They also established water and electricity capabilities for newly constructed buildings and for firefighting functions.[645]

The 823d RED HORSE team at Al Udeid AB initially was scheduled to deploy earlier in 2001 to Masirah AB on Masirah Island located off the coast of Oman. The U.S. Congress had allotted $18 million in MILCON funding in early 2001 for repairs to the runway and taxiway at Masirah AB. The September 11, 2001 attacks resulted in a drastic change in priorities and the 823d team was sent to Al Udeid AB to construct the aircraft ramp. Work at Masirah AB was postponed until 2002. In the meantime, Air Force civil engineers from nearly two dozen bases in CONUS deployed to Masirah AB.

Taking time off from their work, members of the 366th Expeditionary Civil Engineer Squadron pose for the initial opening of Al Udeid AB, Qatar.

Personnel included squadrons from Louisiana, Texas, Missouri, Pennsylvania, and Indiana. Air Force civil engineers quickly began erecting tent cities. The first tent city accommodated 1,800 personnel. Teams completed the city in less than ten days. The second tent city was for the future deployment of 2,200 troops and the third was for an additional 1,400. Air Force civil engineers also established a large power plant and reverse osmosis water purification unit facility to support the growing number of personnel.[646]

The ADVON team of the 819th/219th Expeditionary RED HORSE Squadron (ERHS) from Malmstrom AFB, Montana, arrived at Masirah AB in September 2002 to kick-off the runway repair project. The task included the rehabilitation of 2,000 feet of the runway and 1,775 feet of the taxiway. Flooding posed a problem at the Masirah AB airfield. RED HORSE teams installed drainage facilities to divert water from the airfield. They then installed tunnels below the surface using boring machines to accommodate steel drain lines. The work required innovative field engineering. Using non-traditional advanced methods, RED HORSE members used trenchless technology to save money and time. This was the first time in DoD history that a construction unit completed a project using horizontal boring techniques.[647]

The solution to the drainage issues at Masirah AB was not the only accomplishment that distinguished the 819th/219th ERHS. The airfield at Masirah AB comprised a 12 million square foot area. One of the many jobs associated with the airfield renovations was a complete survey of the area. Once again, RED HORSE teams found a way to complete the task while saving money and time. Personnel utilized Global Position System (GPS) technology to map the entire site in two days. For construction, they utilized a grader that incorporated GPS equipment. This advanced technology revolutionized military construction. Capt. Ryan Novotny, who was a project engineer with the 819th RED HORSE Squadron at Masirah, remarked, “anywhere the operator drove on the airfield, the grader blade would match the design required at that location. GPS was used for every aspect of the project, saving 6,000 hours in surveying and construction.” Once more, the 819th/219th ERHS made DoD history. They were considered the first construction unit to apply GPS for both project surveying and construction. They were also the first Air Force unit to use GPS-guided construction vehicles.[648]

Once the runway and taxiway at Masirah AB were restored and covered with asphalt, the teams installed and verified the operational capability for 706 lights and 48 electronic signs. The system was tedious, necessitated precision in installation, and incorporated 150,000 feet of channels to accommodate electric wires and lightning protection.[649] The runway and taxiway work was a huge accomplishment for the RED HORSE teams. Captain Novotny summarized the achievements of the project,

> all said and done, the team pumped enough water to fill eight Olympic-sized swimming pools, hauled the equivalent weight of 1,665 fully loaded C-17s, paved an area the size of 60 football fields, and placed enough electrical cable, counter poise and conduit to stretch up and down Mount Everest six times. In 170 days, the 819th/219th ERHS made its mark at this forward location and contributed to the capability of the United States Air Force. To the HORSE![650]

Beginning in fall 2000, AFRES civil engineers assumed responsibility for civil engineer operations at Al Dhafra AB, UAE, as part of a peacetime AEF deployment. Personnel from the ANG as well as 16 AFRES units established and supported a base civil engineer function. Following the September 11, 2001 attacks, additional troops were deployed to Al Dhafra and the base was transformed overnight into a forward operating base (FOB). The 49th CES from Holloman AFB, New Mexico, joined the ANG and AFRES units to assist with beddown operations. The rapid escalation in troop population at Al Dhafra taxed the capacities of on-base water and sewage facilities. The host nation, UAE, served as a resource to the Air Force civil engineers on purchasing water and advising troops on the most efficient supply routes. In addition, UAE provided engineering assistance when needed and UAE base firefighters trained with the Air Force firefighters on base.[651]

In January 2002, the 820th RED HORSE Squadron deployed to Al Dhafra AB and began construction of an aircraft ramp. This $17.6 million MILCON project took six months to complete. The one million square-foot project was larger in area than the ramp at Al Udeid. In addition to the ramp, a taxiway was constructed along with lighting equipment, and a hydrant system. RED HORSE completed the project with AFCAP assistance.[652]

In January 2003, a 20-person team from the 320th Expeditionary Civil Engineer Squadron (ECES) forward deployed to Kandahar AB in Afghanistan from its location at Seeb, Oman. The team's primary mission was reconstruction of Air Force Village, a tent city. Although the U.S. Army was the principal military branch overseeing base operating support at Kandahar AB, the Air Force often was called upon to complete specialized tasks. The Air Force team was assigned several tasks that included repositioning 16 TEMPER tents, constructing five hardback tents, and creating a medical supply storage area. One challenge was relocating and constructing tents without disturbing routine base operations; medical activities were a particular concern. Disruptions to electrical power were kept to a minimum. Air Force civil engineers obtained permission for a 48-hour shut-down of certain facilities. To accomplish the work within the 48-hour time frame, personnel worked two 18-hour days back-to-back. In addition to their other assignments, Air Force civil engineers installed trailers with modern lavatory facilities. The 320th ECES worked together with the U.S. Army and other civil engineers assigned to the base to accomplish the assignment.[653]

Firefighters from 354th CES from Eielson AFB, Alaska, faced many difficulties during their deployment in 2002 to Bagram AB, Afghanistan, ranging from equipment shortages to base duties and off-base humanitarian responses. Fire calls from outside the base often necessitated that security forces accompany Air Force personnel for protection and to keep interested civilians and media away from the fire. Other fire responses involved land mines and presented unique challenges.[654] The 320th ECES Fire Protection Flight not only provided regular emergency services, but also trained in joint exercises with the host nation's military and international airport fire department.[655]

EOD members of the 320th ECES deployed to Bagram AB provided vital force protection. Teams constructed protective barriers and a search pit. The EOD flight also conducted hands-on-training twice a week to educate Airmen on the weapons systems found in Iraq and Afghanistan.[656] Other members of the 320th ECES cleared the perimeters of the base from debris and obstructions for the placement of 165 barriers.[657]

By 2002, the cost of RED HORSE projects supporting OEF totaled approximately $90 million; RED HORSE efforts resulted in the largest volume of troop labor construction work since the Vietnam Conflict.[658] The projects completed by Air Force civil engineers during the early years of OEF were large, complex, and challenging. The Air Force civil engineers achieved many "firsts" during this period in construction technology and field engineering. They encountered challenging working conditions, performed with distinction, and proved to be instrumental to wartime operations. Col. Tom Ryburn, who served as Director of Civil Engineering for the Combined Forces Air Component Command, recalled his observations during OEF:

> All our engineers demonstrated leadership, training, motivation and ingenuity. The results we achieved were certainly satisfying to those of us who've watched the Air Force civil engineer business grow and develop. It was an honor to serve with the great engineers of OEF. To sum it up, "No one comes close!"[659]

Sustainment and Reconstruction in Afghanistan

The U.S. military focus shifted away from Afghanistan after the start of Operation Iraqi Freedom in March 2003. Operating bases in and around Afghanistan continued to be sustained. Towards the end of the decade the U.S. military focus shifted back to Afghanistan. Air Force civil engineers continued to support air bases in the region and joined in reconstruction efforts in Afghanistan.

In summer 2005, Air Force civil engineers collaborated with U.S. Army personnel to dismantle K2 AB in Uzbekistan. On July 29, 2005, Uzbekistan advised the United States to remove all U.S. forces from the base within 180 days. Air Force civil engineers had deployed to and from K2 since 2001. Millions of dollars in projects, including aircraft ramps and lighting systems, had been invested in the base. Funding for $700,000 in new projects was authorized, but canceled upon announcement of the closure. Air Force civil engineer teams completed the projects that were already in-progress. As Air Force civil engineers organized the transfer of supplies and material to other bases within the AOR, the U.S. Army initiated site cleanup. The removal effort was an immense logistical challenge for both Services. The Air Force assets had to be removed prior to the environmental remediation by the U.S. Army. Other bases in the theater had to accommodate additional aircraft and equipment. Local contracts needed to be negotiated to support temporary on-base facilities, water supply, and generators during the closure. The removal effort required close coordination and open communications between the U.S. Air Force and Army. The success of the withdrawal from K2, completed November 21, demonstrated the ability of the Services to work together effectively in a fast-paced, high-stress situation.[660]

During 2007, Bagram AB in Afghanistan was expanded under the Accommodation Consignment Agreement between the United States and the Islamic Republic of Afghanistan Minister of Defense. The agreement authorized the base expansion by over one thousand acres. Bagram AB was the main staging center for coalition troops in Afghanistan and the expansion made possible the development of improved accommodations for personnel. With the 755th ECES in charge, facilities added to the base included a "gym, dining facilities, a multipurpose facility, a contractor village for large military construction projects, surge housing, war reserve materiel storage, a landfill with an incinerator, and a wastewater treatment plant."[661] Bagram AB was improved on an ongoing basis to support the influx of coalition forces. In 2008, plywood structures, B-Huts, were replaced with more permanent construction under a multi-year project involving both U.S. Air Force and Army personnel. The project made reassignment of approximately 18,000 personnel from plywood buildings to masonry or metal facilities possible. During this same period, base roads were repaved, traffic lights were installed, water and sewer capabilities were enhanced, and the runway was expanded. Once again, the 755th ECES was involved in the project.[662]

Replacement of B-Huts was not the only project underway at Bagram in 2008. The 455th ECES was involved in an immense effort to improve the airfield, which incorporated 25 projects totaling over $73 million worth of work. An additional $221 million in work was anticipated for the following year. Primary projects in the 2008 work plan included the enlargement of ramps and the addition of a taxiway. Areas to accommodate aircraft ammunition handling also were created. Work was undertaken by the 455th ECES, 1st Expeditionary RED HORSE Group, the Bagram facility engineer team, and contractors. In addition to providing construction capabilities, the 455th ECES also provided force protection escorts, safeguarding project sites from potential threats.[663]

In 2006, the Air Force joined the Provincial Reconstruction Teams (PRTs), which were first introduced in Afghanistan in 2002. PRTs were developed to rebuild the infrastructure of the country and comprised such civic projects as bridges, roads, schools, and irrigation systems. Air Force firefighters established fire academies and trained their Afghan counterparts in techniques and equipment.[664] A single team of three Air Force civil engineers managed nearly 90 construction projects in the Paktya province of Afghanistan in 2008 and 2009. The team oversaw the construction of 20 schools and hybrid power grids, which utilized solar power.[665] Air Force civil engineers working with PRT teams in the

Air Force Master Sgt. Jonathan Estrada, Civil Engineer for Kapisa Provincial Reconstruction Team from Yuba City, Calif., takes a measurement during a site survey for the proposed Abdul Hadi Padar secondary school in the Nijrab valley.

Kapisa and Parwan PRT in 2009 provided guidance for the construction or renovation of 14 roads, 14 schools, 2 courthouses, a mosque, and a medical clinic within a period of two months.[666]

With the drawdown of troops in Iraq in 2009, military personnel once again began deploying to Afghanistan as the United States shifted its focus to Operation Enduring Freedom. On June 3, 2009, the 809th Expeditionary RED HORSE Squadron was activated in Afghanistan to support joint requirements and under NATO tactical control. The unit completed major airfield construction also at FOB Dwyer in southern Afghanistan. In 2009, the 809th ERHS, for the first time in RED HORSE history, undertook the comprehensive design, construction, and operation of an assault airfield. The new flightline for the airfield extended 4,300 feet and the overall construction site was 645,000 square feet in size. The project was not only large, but also complicated by over 100 degree temperatures and high winds. In addition, the arid environment was conducive to rapid evaporation and water for site preparation was at a premium. As a result, RED HORSE personnel trained at Kandahar AB to gain expertise in well drilling. Three wells were drilled to supply water for construction. When the subsurface of the airfield was readied, area contractors were unable to deliver the materials necessary to install the final layer of aggregate. As a result, RED HORSE personnel worked with the 371st

Airmen assigned to the 809th Expeditionary RED HORSE Squadron work on an assault airfield at FOB Dwyer, Afghanistan.

Marine Wing Support Squadron from Yuma, Arizona, to complete the project. Labor and equipment also were provided by the Navy Seabees and area contractors. An AM-2 mat system was designed to accommodate heavy cargo planes travelling to and from FOB Dwyer. The joint teams produced and installed the matting, which comprised 40,000 aluminum components. Other projects at FOB Dwyer included the creation of a 200-foot by 2,000-foot helipad.[667]

In 2011, the 809th ERHS constructed two runways at a forward operating base in southern Afghanistan in less than 45 days to support preparation for an expected surge in Taliban operations in the area. Working with Seabees, they built a 3,000-foot expedient runway using materials available on-site and a 3,000-foot cement stabilized runway. By 2012, the unit had shed its joint taskings and was supporting operations at only Kandahar in preparation for inactivation.[668]

On September 18, 2009, USCENTCOM issued a Fragmentary Order creating the 577th Expeditionary Prime BEEF Group (EPBG). This was the first Air Force organization to actually use the Prime BEEF moniker. The 577th Expeditionary Prime BEEF Squadron (EPBS) was established at Bagram AB and the 777th EPBS was created at Kandahar AB in southern Afghanistan. Six months afterward, the 877th EPBS was added at Mazar-e-Sharif in northern Afghanistan. The 577th EPBG included active duty, AFRES, and ANG personnel with a wide range of qualifications.

Based on the experience of the 732d Expeditionary Civil Engineer Squadron in Iraq, the EPBG concept increased troop flexibility and facilitated the relocation of personnel between FOBs and specific areas as required in support of operational needs. The EPBG organizations remained under the Air Force chain of command, but were specifically focused on delivering all planning, programming, and sub-MILCON design and construction management to the joint command. The new organizations were assigned based on the "hub-and-spoke" model, so teams of Air Force civil engineers could be sent from the main bases to meet specific needs. This new organizational structure was designed to maximize use of Air Force civil engineering capabilities and core competencies in an efficient manner.

SrA Jonathan Carmona, a structural journeyman assigned to the 777th Expeditionary Prime BEEF Squadron, secures square tubing to a metal frame at Kandahar Airfield, Afghanistan.

By 2010, EPBG personnel were assigned in more than 90 localities across Afghanistan. In May 2010, the 577th EPBG paired Air Force civil engineers from the 877th EPBS with the 777th EPBS to support Hamkari Baraye Kandahar (Cooperation Kandahar). Prime BEEF personnel, along with Army and Navy forces, surveyed policed areas, such as checkpoints and governmental buildings, to assess weaknesses in force protection. Many of the surveyed sites were enhanced or enlarged to provide greater security and to create stability for the citizens of Kandahar.[669]

The 777th EPBS provided beddown support for the 2d Brigade 101st Airborne Division and the 1st Battalion of the 71st Cavalry Regiment during Hamkari Baraye Kandahar. For the 101st, Prime BEEF personnel bedded down over 3,000 personnel in three weeks. They provided training for the 101st and for a Naval Mobile Construction Battalion, in tent construction techniques as well as utility and general maintenance skills. The 777th EPBS proved repeatedly that its members were experts in their fields. The group was known as "Afghanistan's 9-1-1 Engineer Force" for its expedient work and training efforts in a joint environment.[670]

Operation Iraqi Freedom

Setting the Stage for Operation Iraqi Freedom

During the years leading up to Operation Iraqi Freedom (OIF), Air Force civil engineers enlarged and rehabilitated bases in the Arabian Peninsula to support ongoing U.S. missions. Work in the region included projects at Doha International Airport and Al Udeid AB in Qatar and Ali Al Salem AB in Kuwait. At Camp Snoopy, located at the Doha International Airport, the 200th RED HORSE Squadron and the 201st RED HORSE Flight worked cooperatively to improve the camp in accordance with force protection guidelines. They also executed 15 additional projects at the camp, including infrastructure

Engineers lay AM-2 matting in a dust storm at a base in preparation for Operation Iraqi Freedom combat operations.

improvements, construction of a Base Defense Operations Center, and erection of observation towers. The 820th Security Forces Group specifically requested RED HORSE for the job. Personnel deployed on March 26, 2000 to initiate project planning and to compile site-specific data. The civil engineers encountered extreme temperatures and challenging soil conditions. Consolidated soils posed difficulties for tasks that required digging. Work at the camp continued for eleven weeks. 1st Lt. Eric H. Mannion, who served as an environmental engineer for the 201st RED HORSE Flight, characterized some of the assignments completed by RED HORSE teams at Camp Snoopy: "the 200th and 201st completed more than 16 projects: erecting a 15-foot-high berm surrounding the base camp for force protection, pouring more than 650 cubic yards of concrete, moving 10,000 cubic yards of dirt, erecting more than 50,000 pounds of steel and laying more than 780 tons of asphalt." The improvements at Camp Snoopy were seen as a training opportunity for the civil engineers, affording opportunities to test their performance in a harsh environment.[671]

A new urgency to improve and expand bases in SWA occurred after the September 11, 2001 attacks to support Operation Enduring Freedom in Afghanistan. Then the U.S. focus shifted to Iraq. Between late 2001 and early 2003, a large buildup of U.S. military personnel and equipment occurred in SWA. Established bases were expanded, new bare bases were established, and airfield pavements were evaluated. Personnel and equipment were positioned in the region.[672] For example, large volumes of firefighting equipment were transported overseas to support air base fire protection efforts. In October 2001, 17 P-19R 1500-gallon fire trucks, 7 P-23R 3000-gallon fire trucks, and 28 P-31 rescue vehicles were shipped to SWA.[673]

In November 2002, civil engineers from Travis AFB, California, were sent to Shaikh Isa AB in Bahrain to support the buildup for OIF. Air Force and Marine KC-135 and KC-130 aircraft were slated to use the base and personnel numbers increased from 800 to 2,300. As a result, Air Force civil engineers were deployed to build an Expeditionary Village to house 1,600 people. The increased

Civil engineers from Travis AFB, California, support the buildup of forces at Shaikh Isa AB, Bahrain.

number of aircraft necessitated the construction of a 385,000 square-foot ramp; an additional ramp was subsequently built at a cost of $20 million. In addition to these projects, Air Force civil engineers were instrumental in establishing a "hydrant loop refueling system." The system required the installation of 3,100 feet of hose to accommodate four aircraft parking locations. The refueling system was completed in ten days and had a capacity to deliver 1,200 gallons per minute. The system ultimately delivered over 20 percent of the fuel expended in OIF.[674]

Air Force civil engineers specifically were requested for an assignment to construct an Air Operations Center (AOC) at Al Udeid AB in Qatar. The center served as the Combined Joint Special Operations Area Command. In January 2003, 13 personnel from the 16th CES at Hurlburt Field, Florida, were deployed to begin construction. Although construction was scheduled to take three weeks, the civil engineer team finished the AOC within 17 days. The project "converted a Frame Supported Tensioned Fabric Shelter warehouse into a facility with 6,000 square feet of office space, intelligence areas, a sensitive compartmented information facility, a communications area, and a 5,000 square-foot auditorium with live feed projection screens to track all operations in theater."[675]

While construction continued at Al Udeid AB, a group from the 16th CES traveled to Diyarbakir, Turkey, to begin work at another special operations site in March 2003. This site was intended to support military activities on the northern front and required beddown facilities to support 7,700 troops. Air Force civil engineer teams from Langley AFB, Virginia, and Little Rock AFB, Arkansas, joined the 16th CES to complete the task. Meanwhile, members of the 16th CES who remained at Hurlburt Field organized teams and equipment for the project in Diyarbakir. Additional teams arrived at Diyarbakir in March. Once the area was prepared for construction, 77 TEMPER tents were erected. The tents featured wood flooring and environmental control units. Air Force civil engineer teams also established a power plant, lavatories, and field kitchens. Before work was completed, the Turkish Parliament did not approve the request for the United States to support OIF from Turkish soil. As a result, the Air Force civil engineers dismantled the expeditionary facilities and vacated Diyarbakir AB on April 20, 2003.[676]

Operation Iraqi Freedom Begins

Operation Iraqi Freedom commenced March 19, 2003. By mid-March 2003, "more than 2,600 Air Force civil engineers were deployed to Southwest and South Central Asia, supporting 18 air and space expeditionary units on 23 bases in 11 countries." [677] Prime BEEF teams provided beddown for deployed troops and supported airfield operations through the maintenance of lighting and aircraft arresting systems. In addition, civil engineers evaluated airfield pavements, maintained electrical power systems, and provided fire protection and EOD support. RED HORSE personnel were organized as the 1st Expeditionary RED HORSE Group comprising the 823d ERHS, the 819th/219th ERHS, and the 307th ERHS. These units were instrumental in completing projects at four bases during the month of March 2003. Initial fighting was over quickly. Baghdad, Iraq, was captured in April 2003 and Saddam Hussein was deposed. After that, Air Force civil engineers continued to serve in Iraq as part of the anti-insurgency and nation building efforts. [678]

Tallil AB (later known as Ali AB), located southeast of Baghdad near Nasiriyah, was one of the first bases in Iraq captured by coalition forces. Tallil was a strategic location during OIF because it provided a forward operating location for the aircraft and helicopters providing air support for ground troops advancing on Baghdad. Tallil AB was the barest of bare bases. It was one of the bases denied by RED HORSE and EOD following Operation Desert Storm in 1991. The majority of the base had been abandoned for over a decade due to its location within the southern no-fly zone. It lacked access to electricity and water. Sand covered every surface. In addition, Iraqi forces had sabotaged the installation to render it inoperative. Iraqi forces had removed electrical wiring, and planted obstructions, including vehicles, at 100 foot intervals along the runways. Lighting was limited and the base initially lacked radar. Coalition forces tasked with rebuilding Tallil AB worked quickly and efficiently. Safety was a priority. Within a week, the airfield was sufficiently repaired to accommodate the arrival of a detachment of A-10s.[679]

Rebuilding Tallil AB was complicated further by mines and booby traps, and unexploded ordnance (UXO) proved a significant challenge for EOD teams. The 407th ECES, the first CES assigned to Iraq, arrived at Tallil on March 27, 2003. The squadron included 28 civil engineers, as well as fire, EOD, and readiness personnel. The Airborne RED HORSE EOD team divided the base into sections and quickly identified and mapped locations of UXO. Disposal of UXO consumed weeks; hidden ordnance were found continually during the ensuing years. EOD teams were kept on standby to assist with ordnance disposal due to the volume of UXO on the base.[680]

Work at Tallil AB continued through summer 2003. Members of the 407th ECES began enhancing the initial systems at Tallil. A water plant and a sewage system were developed. The latter system drew water from the Euphrates River canal located three miles away. Large portable generators were installed making possible air conditioning and laundry services, and reverse osmosis water purification units were activated.

In June 2003, members of the 1st Expeditionary RED HORSE Group arrived at Tallil AB. The 11-man heavy operational repair team renovated flaking sections of the runway surface. The rehabilitated runway sustained aircraft landings over a longer period and enabled larger planes to land at the base. According to 1st Lt. Bryan Cooper, who served as the group's deployed commander, the runway "hasn't been repaired for the past twelve years—probably not since the Iraqis left it after the end of the first Gulf War."[681]

Within four months, the 407th ECES completely changed the landscape of Tallil AB. According to MSgt. Don Perrien, who served with 407th AEG Public Affairs, the 407th ECES "moved more than 9,500 truckloads of fill dirt, assembled over 350,000 square feet of facilities, trenched over 40,000 feet of electrical cable and buried more than five miles of underground water piping."[682] In September 2003, the 332d ECES, with the 332d Expeditionary Mission Support Group (EMSG), began work on tent improvements throughout the base. The tents were elevated atop poured concrete floors. The higher tent elevation eliminated flooding and discouraged rodent infestation. The work was completed in phases to accommodate the day-to-day activities of the base. Equipment shortages resulted in minor delays in the project schedule. When all tents were elevated, the structures were cleaned and treated with insecticide to control flies. The project improved living conditions at Tallil and was a source of pride to the occupants.[683] Maj. Michael R. Wehmeyer, commander of the 332d ECES, explained, "our mission is to protect, operate, maintain, and improve the physical environment (facilities, infrastructure, and utility systems) of the Tallil Air Base community…however, without the other EMSG squadrons backing us up, we'd just be bystanders."[684]

Maintaining Tallil AB was a continuous project throughout the decade. Typical projects included maintaining and repairing environmental control units, air conditioners, and refrigerators. Extreme temperatures and blowing sand cause heavy wear on the equipment and necessitated frequent maintenance checks.[685] In 2005, civil engineers from the 407th ECES enlarged the base medical clinic. Prior to the construction effort, the clinic occupied one expandable storage container with a second unit utilized for storage. The expansion project provided welcomed privacy to patients and to the medical staff.[686]

In April 2003, U.S. military forces entered Saddam International Airport. The airport soon was renamed Baghdad International Airport (BIAP). Maj. Richard Reid, who served as the officer-in-charge for the 114th CES ANG Prime BEEF team, was the interim base civil engineer for BIAP. Major Reid described the situation when he arrived:

> I started the whole bare base process. Here I was, a guy who had once been active duty for a long time and was now in the Guard, who suddenly found himself on the spot, as the first civil engineer in Baghdad, in charge of setting up a bare base with no resources: no vehicles, no tents, no sources of food, and many other things. It was a unique opportunity.[687]

An Airborne RED HORSE team poses in the "Mother of all Craters" at Baghdad International Airport before beginning repairs. The crater was 135 feet wide and 40 feet deep and filled with water 15 feet deep.

Even though resources were not immediately available, Major Reid and a group of civil engineers began planning for a tent city. Airborne RED HORSE EOD teams assessed the site, which covered one million square yards. They also initiated crater repairs, repaired the runway, and installed an Emergency Airfield Lighting System.[688] Maj. Markus Henneke and a team of engineers from Ar'Ar, Saudi Arabia, arrived in mid-May, joining engineers from Davis-Monthan AFB, Arizona, and Langley AFB, Virginia. Over the next few years, Air Force civil engineers completed numerous projects at BIAP. Air Force civil engineers of the 447th ECES installed over 5,000 feet of pipe to connect with a 5,500 gallon water holding tank. The utilities team established water service for more than 20 base facilities. In addition to the water system, the civil engineers erected a lift station and wastewater pipe at the site.[689]

Balad AB was another base sustained by Air Force civil engineers. Considered the DoD's "busiest single runway," Balad AB was home to "the largest combat search and rescue operation since Vietnam, the most forward deployed Predator operation, the largest C-130 squadron, and more than 2,000 combat sorties per month." Between 2005 and 2008, Air Force civil engineers deployed to Balad AB completed $330 million in construction projects.[690] A critical ongoing project was maintenance of the runway by the 332d ECES. The engineers responded to live-fire attacks, assessed damage, removed debris, and executed repairs necessary to keep the runway operational. In 2005, members of the 332d ECES constructed a second runway at Balad AB in 40 days.[691] In July 2007, the 332d ECES completed an "emergency partial-depth repair" of the runway. After the temporary repair was complete and flight operations restored, the Air Force civil engineers planned for a full-depth repair of the spall and of an expansion joint. Permanent repairs were completed in three weeks and the runway was completely operational.[692]

The 332d ECES also provided services to the Air Force Theater Hospital in Balad. Members of the team replaced deteriorated tents under extreme stress. Due to the intense combat situation at Balad, construction of the intensive care units had been completed in 24 hours. Prior to the tent replacement project, Air Force civil engineers corrected the site drainage. Flooding around the tents was a major problem during the rainy seasons. Utilities and Heavy Repair experts installed drain pipes at regular intervals in the Hesco barriers to drain water away from the tents. The project was completed in 13 days and involved the replacement of 46 tents, 20,000 sandbags, 12,000-feet of power cable, and over a mile of electrical wiring.[693]

Preservation of Balad Hospital

The 332d Expeditionary Civil Engineer Squadron worked with the 332d Expeditionary Medical Group at Balad AB, Logistics Support Area Anaconda to preserve an important structure. During Operation Iraqi Freedom, the Balad Hospital was known in the medical community as "the place where the most American blood was spilled since the Vietnam War."[694] An August 2007 visit by a Congressional delegation began an effort to save the emergency room after the new Air Force Theater Hospital was completed. In 2007, plans were established to save Bay II and as much as possible of the temporary tent structure that served as the Balad hospital. The 332d ECES faced several obstacles in tearing down the structure without damaging the historical integrity. Maj. Scott Bryant, 332d ECES operations flight commander commended his troops on their job, "Successfully removing the 7-foot by 7-foot, 6-inch thick solid concrete slab, weighing more than 6,000 pounds, without an extra crack or chip shows the tremendous effort, dedication, and pride our civil engineers took in preserving this piece of history." The project was a complete success with all artifacts and objects being packaged as well. The entire emergency room was shipped to the National Museum of Health and Medicine in Washington, D.C., and put on public display in 2008.[695]

Members of the 332d ECES Fire Protection Flight worked alongside Army firefighters to combat a fire at Joint Base Balad, Iraq in 2008. The fire resulted in $1 million in damage and destroyed six structures.[696]

In 2008, base support at Balad AB was turned over to the Air Force; the U.S. Army retained its logistical headquarters on base. On June 15, 2008, Balad AB was renamed Joint Base Balad to reflect joint use of the base by both Services. Joint Base Balad was the preferred base for launching aircraft missions in Iraq.[697]

"In Lieu Of" Taskings

Over 4,500 Air Force civil engineers responded during the early years of OIF, supporting approximately 64,000 Air Force personnel. Construction projects involved 211 contracts totaling $329 million.[698] As OIF continued, Air Force civil engineers began providing direct support to the U.S. Army through "in lieu of" taskings to Army missions. Air Force civil engineers were utilized by the Army to fill gaps in several areas, including engineering, utilities, EOD, and fire protection services. Beginning in January 2004, the 732d ECES at Balad AB in Iraq played a major role in meeting the needs of the Army through the support of the U.S. Army Combat Support Service. The 732d was part of the 732d Expeditionary Mission Support Group at Balad. The unit's mission was to "provide engineer utilities, design and firefighting direct and general support to the U.S. Army Combat Service Support from platoon to corps level throughout Iraq and Kuwait."[699] Lt. Col. Karl "Boz" Bosworth was the unit's first commander, coming from the position of commander of the 355th CES at Davis-Monthan AFB, Arizona. The 732d's mission was a first for Air Force civil engineers and was a dramatic change in the historic relationship between the Air Force and Army, where the latter was responsible for providing engineering support to the Air Force.[700]

The 732d ECES was placed in charge of developing a "combat-ready engineer," qualified to perform security functions and to deploy rapidly in response to Army missions. Teams completed specialized training under the early phase of coordination between the 732d ECES and the U.S. Army. This training was organized and led by military personnel with recent and extensive field experience. Navy SEALS, Special Forces, and Army Rangers were involved in the training, which prepared Air Force civil engineers to operate "outside the wire." Training with live ammunition, Air Force civil engineers mastered techniques for firing from moving vehicles and weapons proficiency appropriate to a rapid combat environment. Participants trained under realistic scenarios. Simulated Iraqi villages with randomly placed "adversaries" armed with a variety of weapons, including grenade launchers, were used. Training culminated in a five-day event using live-fire. Lt. Col. Jeffery A. Vinger, the second commander of the 732d ECES explained the skills of the successful trainees: [701]

> the team must demonstrate the lessons they've learned in all aspects of convoy operations, including preplanning, conducting rehearsals, giving convoy briefings, establishing correct vehicle placements, massing fire on the move, suppression of enemy fire, executing rally point operations, recovery of disabled vehicles, defense of the stopped convoy, treating and evacuating casualties, and the increasingly important task of identifying, avoiding and reporting improvised explosive devices. [702]

Following the training, 732d ECES members received Army assignments. Air Force personnel then "shadowed" and worked alongside the outgoing Army personnel, who were charged with assessing their performance. By the end of 2004, approximately 500 Air Force civil engineers were divided into separate detachments throughout Iraq, Kuwait, and Qatar.[703] The detachments provided direct and general support to the U.S. Army Combat Service Support from platoon to corps level throughout Iraq and Kuwait and were divided into several categories:

- Design Flights: Provide engineering design, surveying and master planning.
- Utility Flights: Provide engineer utilities, infrastructure, operations, maintenance, and construction support.
- Fire Flights: Provide firefighting direct and general support.[704]

The command relationships for these detachments were a challenge for 732d ECES leaders. The Air Force retained administrative control (ADCON) and operational control (OPCON) over the Air Force members supporting the Army. The Army was given tactical control (TACON). The exact definition of TACON was a frequent item of interpretation for Army and Air Force leaders. Lt. Col. Jeffrey Vinger, 732d ECES commander described one situation:

> In one case,…they [Army] wanted to break up one of our utility teams and send them to another site somewhere else to provide oversight, construction management and utility support. This other site was half a country away so there would be no interaction really other than e-mails and telephone calls between that new flight commander and his flight commander that he deployed with. That to me, was essentially an OPCON issue where they shouldn't be able to break up our teams. They can give them the day-to-day operations of what they are to do but not to break our teams up and send them all over the place…. But to physically break a team apart and now decide you have a new mission over here full time for the rest of your tour, was a foul as far as I was concerned and I battled that one all the way to the end.[705]

In 2004, Air Force civil engineers were deployed to Abu Ghraib Prison in Iraq as Detachment 5 of the 732d ECES. The deployment was part of Multi-National Force-Iraq Detention Operations. The facility had been abandoned in 2003. Air Force civil engineers and contractors assisted the U.S. Army in operating and maintaining the prison as a FOB. Air Force civil engineers completed daily tasks, such as repairing infrastructure and maintaining HVAC systems. Civil engineers also were required to sustain proficiency in ground transportation and supply.[706]

Abu Ghraib was a particularly challenging assignment due to its location. The prison was surrounded by an anti-coalition population. All areas outside the perimeter of the prison were within the war zone. Air Force civil engineers at Abu Ghraib were armed. Maj. Marie Kokotajlo, commander of a Prime BEEF team located at Abu Ghraib, and the Airmen under her command, experienced the extreme vulnerability of the location, "only a few days after our arrival, a mortar round hit in the yard, scattering a dozen Airmen into the bunkers and nearby buildings; three of my Airmen received Purple Hearts." Major Kokotajlo's team worked outside of the prison boundary to repair barriers and remove debris while on constant alert for IEDs. This work required Army and Marine escorts in gun trucks. In some cases, tanks were used to create a barrier between the civil engineers and nearby residences. Helicopter gunships also circled while work was completed.[707]

Regular supply trips from Abu Ghraib to BIAP were undertaken under the constant threat of attack. Strategically planted IEDs appeared daily along the routes used by U.S. forces. Major Kokotajlo commented on the exemplary performance of the Air Force civil engineers at Abu Ghraib, "they represent a whole new breed of Combat Airmen: engineering professionals with veteran combat and soldier skills. They've proven their adaptability, skill and courage in a violent combat environment, and they've learned to depend on each other, no matter the threat." In addition to the Air Force civil engineers' stellar performance in a hostile environment, the work at Abu Ghraib also demonstrated strong solidarity to the joint operation.[708]

Members of the 732d ECES, Detachment 6 deployed to Logistic Support Area Anaconda for an "in-lieu-of" tasking. The civil engineers supplemented Army engineers to construct two hardened operating facilities for munitions. To complete the facilities, the 732d ECES moved 7,000 cubic yards of fill and constructed earthworks to correct flood problems in the area. In addition to the hardened

Airmen and soldiers load into the back of a Mine-Resistant Ambush-Protected vehicle at Joint Base Balad, Iraq. The Airmen, who are assigned to the 732d Expeditionary Civil Engineer Squadron, Detachment 6, undertake construction projects for the Army, while the soldiers provide convoy security.

facilities, the civil engineers constructed 10-foot revetments stretching 915 linear feet.[709] The 732d ECES also completed extensive construction and infrastructure projects at joint force locations in the Diyala River Valley and FOB Base Caldwell. Army Captain Timothy Hsia commended the unit,

> The Det 6 team planned, procured, resourced, and established several life-support functions at the JCOP [joint combat outpost], including a power grid; electrical wiring; generator set-up and maintenance; heating, ventilation, and air conditioning unit configuration; and latrine and shower unit establishment…they ensured all 72 living containers were wired for power and air conditioning units. The team also engineered and built several structures on the JCOP such as civil military operations center building, the company tactical operations center, and five Iraqi army buildings.[710]

Work with the U.S. Army presented new challenges for Air Force civil engineers and training continued to be a priority. General Eulberg, The Civil Engineer, discussed these joint projects in a 2006 interview:

> Half of the folks deployed—roughly 1,500—are doing "in-lieu-of" taskings, primarily supporting mission areas that typically reside in other Services, such as the Army, and doing some things that we weren't traditionally organized, trained and equipped to perform. So we've had to jump into the fray and develop pre-deployment training to ensure that our troops are prepared before they are deployed. This has been and will continue to be a priority of the Air Force Chief of Staff.[711]

In 2009, "in lieu of" taskings became known as Joint Expeditionary Taskings.[712]

RED HORSE in Iraq

As discussed above, RED HORSE played an important role in support of OEF and OIF. Multiple units deployed personnel to all areas of the AOR to provide their specialized engineering capabilities. One new capability that was developed during this time was Airborne RED HORSE. The formation of an airborne RED HORSE capability began in 2001. In 2002, Brig. Gen. Patrick A. Burns, who served as the ACC Civil Engineer during OEF noted:

> The one capability I wish we had is airborne or air-droppable RED HORSE. There were several times when we would have liked to have a small team of engineers and heavy equipment air-inserted into Afghanistan locations to make expedient repairs in order to land C-130s and C-17s. We were already studying the idea, but as a result of September 11 we are now pursuing it aggressively.[713]

Gen. John P. Jumper was another proponent of the airborne RED HORSE. General Jumper had noted situations in the field during Desert Shield/Desert Storm where a RED HORSE team with airborne capabilities would have been extremely beneficial. When he became ACC Commander, General Jumper advocated a "jumping HORSE." The need for a lean, compact, rapidly deployable, airfield repair team was evident based on the early days of OEF and the "jumping HORSE" was born.[714]

The airborne engineer idea was not a new one. Sixteen Airborne Engineer Aviation Battalions were formed during World War II. The key issue with these early airborne engineers was equipment. They utilized small-scale air-transportable machines, including bulldozers, graders, jeeps, and carryalls. The equipment was cumbersome to transport and could not sustain extended use, especially in muddy terrain. By 1944, the majority of airborne battalions had abandoned their equipment and joined conventional battalions. The need for airborne engineers in the twenty-first century was revisited during OEF as a result of the need for rapid responses to new locations.[715]

The early planning stages for the airborne RED HORSE included the evaluation of equipment. Representatives from the 819th, 820th, and 823d RED HORSE Squadrons participated in field training exercises with U.S. Army engineers to evaluate techniques and machinery. General Burns then established a timetable for the 819th RED HORSE Squadron to begin its own exercises in airfield damage repair. The exercises allowed engineers to determine what equipment was necessary, focusing on efficiency and durability. As a result, a new equipment package was created, Mobile Airfield Repair Equipment Set. The packages were light, yet able to endure sling loading and parachute drops.[716]

Another requirement to execute a RED HORSE squadron with airborne capabilities was the creation of a "parachute-qualified team of engineers." Members of an airborne engineer team were required to deploy rapidly to sites with their equipment and address future landing capabilities. These activities included repairing existing runways or clearing areas for new landing sites. During the planning phase, it was anticipated that an airborne engineer team would deploy as one unit or work within a group during large operations. The team would not be tasked with capturing airfields, but only deployed to airfields operated by U.S. or allied forces. The airborne RED HORSE was projected to have self-supporting capability during the initial 72 hours at a location. Once sustainment was available through additional forces, the teams could remain operational for at least 14 days before being replaced or augmented by follow-on teams.[717]

Four stages of contingency operations for the airborne RED HORSE were "deploy, assess, prepare, and establish." These stages were aligned with the Air Force Air and Space Expeditionary Force "force modules." The actual responsibilities for each stage were extensive. Tasks for the airborne engineers included:

> rapidly deploy into austere locations, assess airfield capabilities, prepare helicopter or aircraft landing areas, clear obstacles, install emergency airfield lighting systems…make expedient airfield damage repairs…test for potable water sources, perform expedient force protection construction, clear explosive hazards, assess potential nuclear, biological and chemical and toxic industrial material hazards, and provide fire rescue and emergency medical services.[718]

These tasks had been part of contingency operations in the past, but usually involved prepositioned resources, materials, and equipment.[719]

Airborne RED HORSE deployed to three sites in Iraq during 2003. The teams were formed from portions of the 819th, 820th, and 823d RED HORSE squadrons. Each airborne team had 35 airborne-qualified airmen comprising 21 with a range of engineering skills, 6 EOD personnel, 6 fire prevention and rescue personnel, and 2 Nuclear, Biological and Chemical specialists."[720]

In April 2005, the 557th Expeditionary RED HORSE Squadron (ERHS) was activated with ANG RED HORSE civil engineers from the 200th RED HORSE Squadron at Camp Perry, Ohio, the 201st RED HORSE Flight at Fort Indiantown Gap, Pennsylvania, and active duty Prime BEEF units from eight different bases. Reactivating a unit designation from the Vietnam era, the 557th ERHS became the in-place unit that accepted other RED HORSE units deploying to Iraq. The combined skills of Prime BEEF and RED HORSE personnel forged a powerful team capable of construction, maintenance, and rehabilitation. The 557th ERHS completed training in CONUS and overseas and was deployed to Ali AB (previously Tallil AB) in Iraq. The 557th worked alongside the U.S. Army 980th Engineering Battalion until the Army departed. Its primary mission was to establish a heliport for the U.S. Army; the project was among the largest construction efforts undertaken within the AOR. The 980th Engineering Battalion finished approximately 60 percent of the project. Completion of the 600,000 square feet of construction fell to the 557th ERHS. A total of 30,000 feet of forms were erected and

U.S. Air Force SrA Franklin Travis Kee, with the 557th Expeditionary RED HORSE Squadron, clamps two panels together while building a new supply warehouse at Camp Ripper, Iraq.

14,000 cubic yards of concrete were poured in the project. The dedication of the team was illustrated by its response to obstacles. When a bomb explosion resulted in crater damage rendering the supply route impassable, the 557th ERHS dispatched a crater repair team and promptly reopened the road.[721]

The 557th ERHS at Ali AB faced challenges while processing cement with a batch plant similar to those encountered in Afghanistan during OEF. The machinery was too small to process the size of the available rock, requiring the far less efficient method of hand picking materials. The water system supplying the batch plant was not dependable, necessitating the transportation of large amounts of water. In addition to the obstacles encountered with construction, personnel faced the constant threat of attack. Rocket and mortar strikes, as well as attacks on vehicles, required the team to be on constant alert. Security for deliveries to the heliport site was expedited when the 557th was authorized to handle commercial vehicle searches. Weather and site conditions also were challenging. Two days of rain prompted a four-day suspension of work in the fourth week of the project; 500,000 gallons of water were removed or redirected from the site. The U.S. Army 70th Engineering Battalion worked with the 557th ERHS to install a 70-foot bridge over a culvert at the site to provide access for supply trucks and heavy equipment. An additional shift was added to meet the project deadline, and the 557th worked day and night to complete the project two days ahead of schedule.[722]

The success at Ali AB in 2005 demonstrated the newly formed 557th ERHS's competency. General Fox traveled through the AOR during the 557th ERHS's initial assignment in OIF. He remarked, "I'm extremely impressed with how this squadron blended, Guard and active units combined."[723] The team brought a range of expertise and adapted easily to project scenarios, illustrating once again the dedication, capability, and professionalism of Air Force civil engineers. By 2007, the 557th ERHS comprised approximately 400 personnel who performed "in lieu of" Army tasks at a dozen sites across Iraq. These projects included tent construction, aircraft ramp repair, equipment repair, and logistics operations. The squadron members viewed themselves as a united team regardless of home unit affiliations. Maj. Richard Sater, a member of the 557th stated, "unit designations don't mean anything over here—you're part of the HORSE."[724]

In 2007, Air Force civil engineers worked with the U.S. Army to construct facilities for FOB Kalsu near Baghdad, Iraq. According to Capt. Kelvin Haywood, who served as the engineer flight commander for the 557th ERHS, "the Army got with the Air Force RED HORSE because we are the experts in construction…because of the many taskings they have for the surplus of Soldiers, they asked us to come out and help them with their headquarters construction here." [725] The team working at Kalsu included 37 personnel deployed from Balad AB, Iraq. Due to evening security black-outs, work was restricted to daylight hours when temperatures rose to over 100 degrees. In addition to the heat, the base was the target of mortar attacks. The 557th team completed work on four operations centers for the U.S. Army, strengthening the functions of FOB Kalsu.[726]

The 557th ERHS Combat Logistics Patrol (CLP) team also provided assistance in the transportation of supplies, personnel, and machinery throughout Iraq. By 2008, the 557th ERHS CLP had transported material to 18 FOBs. At Balad AB, the CLP team included mechanics, as well as security and medical personnel. The team was proficient in security-equipped cargo transportation and able to convoy up to 500 tons a day. Teams also were proficient in the installation of secure boundaries to enhance safety within project areas. Convoy operations were, again, complicated by IEDs and bombs planted along transportation routes. SSgt. Mitch Romag, who served as a gunner for cargo operations with the 557th ERHS, explained the stressful conditions that accompanied the identification of an IED:[727]

> A lot of things run through your head while stopped for an IED on a main or alternate supply route traversing the middle of Baghdad. Until it's defused, we're sweating in a cramped HUMVEE gun truck with our night vision goggles on, looking for any potential threats. We don't like to take an alternate route around, because we don't

> want to leave [the IED] there to detonate on the next coalition force convoy passing through. It's pretty unnerving, though just sitting there, waiting for the enemy to draw a bead on your location. [728]

Civil engineers supporting construction and cargo transport within Iraq expanded the Air Force portfolio of experience of war zone operations. These on-the-ground assignments fostered team solidarity and cooperation among the U.S. Armed Services.

Explosive Ordnance Disposal (EOD) Personnel

Adopting the motto "Initial Success or Total Failure," Air Force EOD personnel provided critical services during overseas operations. EOD personnel initially were tasked with maintaining security for aircraft and their weapons, securing air bases and operating locations from incoming rocket and mortar attacks, and force protection. Force protection extended to recommending improvements to installation base security, screening suspicious packages, and dismantling IEDs to protect deployed U.S. troops. One major continuous job at all bases was dismantling and removing booby-traps and destroying caches of abandoned Iraqi munitions. All new construction or digging to construct air bases required UXO clearance prior to beginning the projects. The hierarchy established by EOD personnel was to clear airfield areas first, then beddown areas, then munitions storage areas. Stockpiles of abandoned ordnance were disposed of through controlled demolitions. At Jalibah Airfield, for example, EOD personnel destroyed over 2,000 UXO left over from the first Gulf War prior to bedding down a Marine Corps aircraft wing. At Tallil AB, EOD teams estimated it would take ten years to dispose of the stockpiles of abandoned Iraqi ordnance. At Kirkuk AB, over a million pounds of explosives were destroyed in the early years of the war.[729]

U.S. Air Force SSgt. Matt Skelton and SSgt. Charles Hodge, 506th Expeditionary Civil Engineer Squadron/ Explosive Ordnance Disposal prepare to detonate a stack of 120-mm Russian mortar rounds discovered near K-3, Iraq.

During the initial months of OIF, nearly 200 EOD personnel were stationed in 25 locations in 13 countries. EOD personnel deployments were managed through the Combined Air Operations Center at Prince Sultan AB, Saudi Arabia. EOD personnel were stationed to support bases operations and tasked to joint missions.[730] One of the first joint missions paired Air Force and Navy EOD personnel in Operation Restore Iraqi Oil to identify and dispose of UXO and IEDs located in the Iraq oil fields. The oil wells were booby-trapped with remote detonation devices and surrounded by UXO. EOD personnel from the 321st ECES and the 384th ECES cleared pathways to the wells and rendered nearly 400 oil wells safe from explosive hazards in 30 days. Over 5,000 UXO and explosive charges were dismantled and neutralized.[731]

Tasks assigned to Air Force EOD personnel expanded to support U.S. Army ground combat operations outside the air bases. In this role, Air Force EOD personnel dismantled and neutralized UXO and IEDs outside air bases to protect both U.S. Army personnel and local civilians. The 447th ECES EOD team deployed to Baghdad in 2003 found its expertise in high demand. In a single day, the team disarmed seven IEDs in widely varying circumstances. The team was summoned to contain further explosions around U.S. Army vehicles that had run into an IED in a local civilian market place and to dismantle IEDs along a major highway used as a U.S. convoy route. The team also dislodged unexploded mortars from buildings. The EOD team worked continually, often under perilous conditions. In one instance, EOD members came under direct fire while disarming an IED. U.S. Army tanks and coalition servicemen provided cover while the 447th EOD team neutralized the IED.[732]

Air Force EOD personnel also continuously trained Air Force personnel about UXO and IEDs, particularly firefighters and first responders. It was critical to ensure the safety of military personnel when encountering UXOs and IEDs and to warn them against collecting UXO as souvenirs. Another critical aspect of the EOD work was to gather information on the ever-changing composition of IEDs and to disseminate the information widely to all personnel needing to recognize and neutralize IEDs.[733] Air Force EOD personnel participated in the joint Weapons Intelligence Teams to go beyond a reactive posture in dealing with IEDs. The teams did sophisticated collection, analysis, and tactical

U.S. Air Force Explosive Ordnance Disposal craftsman MSgt. Joe Cross ropes off a safe area far from an uncontrolled natural gas fire in the Rumaylah Oil Field in southern Iraq.

exploitation of IEDs in an effort to gain clues on the enemy's identity and methods and prevent the IEDs from ever exploding. The teams also uncovered weapons caches to prevent them from being used against coalition forces. Air Force EOD personnel also trained in-country counterparts in EOD techniques and worked with local civilians to remove caches of UXO.[734]

Because EOD personnel became such a valuable asset in Iraq, many were put under Combined Joint Task Force Troy that was established in 2005 as the first operational counter-IED task force in U.S. military history. Serving with their fellow EOD technicians, EOD Airmen brought their expertise and experience to combat the Counter-IED threat throughout Iraq. Troy brought together EOD personnel with a variety of backgrounds to gain information and intelligence that could be shared with coalition forces to improve their safety.[735]

As U.S. involvement in Iraq continued, a marked increase occurred in the use of IEDs against U.S. military personnel. In 2005, 50 percent of attacks against U.S. and coalition forces involved IEDs; in late 2006, IEDs accounted for 75 percent of attacks. Air Force EOD personnel participated in 45 percent of joint-force EOD missions in USCENTCOM during 2006, which numbered 8,319 incidents, of which 3,456 involved IEDs. EOD personnel were the first line of defense against IEDs in both Iraq and Afghanistan. This role was recognized in May 2006 when EOD became one of four Air Force specialty codes included on the Secretary of Defense's critical skills list. Reorganizing the deployment rotation to increase the number of available Air Force EOD personnel became a high priority for Air Force civil engineer leadership. The minimum standard for EOD personnel deployment became 179 days. Many EOD Airmen served multiple deployments to the AOR, often volunteering for these dangerous missions.[736]

In 2007, the Air Force EOD personnel numbered approximately 1,200 active duty members who were 100 percent deployable.[737] The number of EOD personnel deployed to Iraq in late 2007 was 157. An additional 67 EOD Airmen were deployed in Afghanistan. Personnel assigned to Iraq were stationed at Baghdad International Airport, Balad, Kirkuk, and Ali ABs, in Baghdad, and at 11 Army forward operating bases.[738] During FY07, EOD personnel responded to 8,776 requests for support, including 3,706 IEDs, 3,682 UXOs, and 1,388 weapons caches. EOD personnel also were assigned to "in lieu of" Army positions. Air Force EOD personnel supplied approximately 30 percent of EOD personnel in joint task forces in both Afghanistan and Iraq.[739] During FY08, EOD personnel responded to 4,612 incidents, comprising 2,091 IEDs, 2,237 UXO, and 284 munitions caches. This significant decrease was the result of a surge of U.S. military forces into Iraq that improved security.[740]

On December 9, 2011, the last Air Force EOD personnel left Iraq. Between March 2003 and December 2011, Air Force EOD personnel conducted over 36,000 missions, 13,400 of which were calls to defuse IEDs.[741] EOD Airmen routinely were recognized for their service during OIF and OEF, receiving Purple Hearts and other citations. By 2012, 9 EOD Airmen had lost their lives in Iraq serving their country.[742]

Iraqi Military Progress and U.S. Drawdown

Once the heavy fighting in Iraq ended, Air Force civil engineers became involved with the stabilization of the security of Iraq and its reconstruction. By 2005, Air Force construction efforts in Iraq exceeded $1 billion. According to Maj. Gen. L. Dean Fox, Air Force civil engineers "have rebuilt schools, clinics, Iraqi military installations…and have rebuilt the Iraqi Ministry of Defense from the ground up."[743] Of vital assistance to the rebuilding effort was the ability to access AFCEE's contracting vehicle WERC described above.

Air Force firefighters, who continued to provide critical services to all air bases throughout the area of responsibility, became involved in rebuilding Iraqi firefighting capabilities. During 2003, a series of four Air Force chief master sergeants served their assignments at the Iraqi Ministry of the Interior to lend their guidance to the process. These firefighters identified needs, budgeted personnel and equipment requirements, developed a seven-year strategic civil defense, and secured funding to build a fire training academy and to contract for training staff. During this time, 100 fire stations were renovated, 27 new fire stations were funded, and 600 new fire trucks were purchased.[744]

Air Force firefighters continued to support Iraqi firefighting training throughout the decade on both the national and local levels. Air Force civil engineers were involved setting up the coursework for the national Iraqi fire academy and served as instructors. A 60-day introductory course conducted by a Coalition Air Force Training Team was adapted for Iraqi participants from the Air Force fire apprentice course. The course taught basic firefighting skills, medical issues, fire control, hazardous materials, structural training, and aircraft firefighting. The first class of firefighters graduated in December 2007. The school was moved in 2008 to the Green Zone in Baghdad where both civilian and military firefighters participated in joint training. A 10-day course to train management skills to firefighting leadership also was offered. The new Iraqi national fire academy opened in Baghdad in January 2009.[745] In January 2009, Air Force firefighting experts from AFCESA deployed to Iraq to assess the fire departments at four Iraqi Air Bases and to establish training standards for the Iraqi air force fire service. Courses were designed to train Iraqi air force firefighters to a level "two" capability, enabling them to "conduct basic interior and exterior firefighting, aircraft rescue firefighting, rescue, first aid and fire prevention."[746]

In addition to efforts to support the national training goals, Air Force firefighters also worked on the local level. At Ali AB, firefighters deployed with the 407th Expeditionary Civil Engineer Squadron Fire Department conducted six week training courses for Iraqis from the local village between 2006 and 2008. These courses provided training for 8-to-10 person classes in basic firefighting techniques, search and rescue, and lifesaving skills. The Iraqis attended six, three-hour training blocks. Class attendees were sent back to their local fire stations with information to share. Another goal was to distribute to the Iraqis donated equipment collected from fire stations in the United States.[747]

In 2007, the political situation in Iraq had deteriorated and the United States sent a surge of troops to provide stability to Baghdad. Air Force civil engineers supported the surge by building facilities for U.S. Air Force, Army and Marine forces in such places as FOB Hammer, Balad AB, and Al Asad AB. Nearly 2,700 Air Force civil engineers were deployed throughout 2007; approximately half of them were assigned to joint or "in lieu of" Army missions. During FY08, the focus of the civil engineers deployed to Iraq shifted to working with Iraqi civilians to improve their living conditions and with the Iraqi military to improve their facilities and to train their engineers and firefighters.[748]

The Provincial Reconstruction Development Committee (PRDC) Program in Iraq was established in 2007 to promote economic and political stability in the region and was identical to the PRTs operating in Afghanistan. Air Force civil engineers were vital to the program. The PRDC originally began with simple infrastructure projects but soon expanded to include the construction of medical facilities, schools, and water utilities. As the projects were completed, they were turned over to the Iraqis. Lt. Col. Douglas P. Wise was the project manager for the 94-bed pediatric oncology and training hospital at Basra.[749]

In 2007, four Air Force civil engineers worked with the Army and Navy at Camp Habbaniyah to train Iraqi Army personnel in base operations. One civil engineer officer, two power production specialists, and one structures specialist provided their expertise to the effort. The Air Force civil engineers worked with Iraqi Army engineers, demonstrating maintenance practices and providing instruction on the maintenance and repair of generators. Civil engineers also provided instruction on water conservation techniques and electrical systems. In addition, the civil engineers provided advice to contractors in planning and organization. Work at Camp Habbaniyah was not limited to training. Capt. Emil Rebik, the civil engineer OIC at the camp, reported that "we responded to suicide bombers, improvised explosive devices, and vehicle-borne explosive devices at the camp's perimeter and entry point." The project proved the civil engineers' capability to work in a wartime environment while maintaining the mission of training the forces from a foreign country.[750]

Village of Hope

While war is an inherently destructive event, military engineers often use their skills to build and rebuild facilities and communities during and after the conflict. One such example during Operation Iraqi Freedom was the Village of Hope project at Hawr Rajab, Iraq. Following the surge of Coalition Forces in 2007, the village had become a relatively safe area as Sons of Iraq members had assisted in pushing out Al Qaeda forces and reconstruction and counterinsurgency operations could begin. Multinational Corps-Iraq created the Village of Hope concept that envisioned the construction of 100 new homes and community facilities. More importantly, it also included a construction training program carried out by 30 members of the 557th Expeditionary RED HORSE Squadron. The students were former members of the Sons of Iraq who learned marketable skills and could then assist in rebuilding their community. The courses were based on existing Air Force skills training curriculum tailored with local building customs and construction materials. While the 557th members were awaiting tools and supplies to begin the course, they began teaching courses in literacy and remedial math, useful skills for engineering work. Eventually, the materials arrived and the Air Force engineers began teaching masonry, plumbing, and electrical skills to 210 students during a 10-month period. The students and instructors remodeled four houses and built a boys' school and a community center. The Airmen also developed a training program for a local concrete-block fabricator to improve the quality of the product with the expectation that Coalition Forces would purchase materials for future construction projects. When Capt. Josh R. Aldred, one of the first instructors, prepared to return to the United States, a group of students wrote a letter that captured the true value of the Village of Hope program,

> In the past, we had different feelings and a kind of misunderstanding towards the American people. After being close to you, we found out that we are almost the same…. This removed the fears we had before, and now we have become very good friends. Tell your people and families about us when you arrive to the United States. Tell them about our good friendship and experience we have had together.[751]

In 2009, Col. Jeffry D. Knippel became the first U.S. Air Force personnel to assume command of a U.S. Army Corps of Engineers District. Colonel Knippel took command of the Gulf Region Division in Iraq. As noted by General Byers, this represented a major milestone "that highlighted the interdependencies of the different service engineers in the Central Command AOR."[752]

Colonel Knippel Made History

Air Force civil engineer Col. Jeffry D. Knippel made history in 2009 when he became the first Air Force officer to command a U.S. Army Corps of Engineer district. Army COL. Jack Drolet relinquished command of the district during a one-hour ceremony in Tallil, Iraq, on July 9, 2009. Gulf Region Division Commanding General, Maj. Gen. Michael R. Eyre presided. Colonel Knippel was the 7th South district commander and was responsible for providing engineering and construction management services for the Gulf Region Division's largest geographic area. The district managed 146 construction projects totaling $688M throughout the nine southern provinces of Iraq (64,000 square miles).

continued

Colonel Knippel Made History *continued*

"Napoleon declared that 'nothing is so important in war as an undivided command.' I believe there is an incredible opportunity here for us to strengthen the bonds within our joint command and I am confident that this outstanding leader from one of our sister services is the person for the job," said General Eyre. "Colonel Knippel is one of the Air Force's finest engineer officers and it is our great fortune that he is joining us."

As he accepted command of Gulf Region South (GRS), Colonel Knippel said, "I pledge to uphold the strongest traditions of the military engineer that are indicative of both of our services. GRS will continue to live up to the proud traditions of the U.S. Army Corps of Engineers." Colonel Knippel was previously AFCEE's chief of Contingency Construction Division. During his tenure with AFCEE, he was responsible for construction management of the Air Force's $700 million military construction program and for construction execution of a $1.8 billion joint and host nation construction program, both in the Central Command area of responsibility.[753]

During 2010, the United States began to draw-down the number of U.S. forces in Iraq. U.S. troop strength was reduced from 112,000 in January to 50,000 in August 2010.[754] During 2010, 20,000 troops were projected to travel through Joint Base Balad, Iraq, as U.S. forces withdrew from Iraq. The 557th ERHS was instrumental in guaranteeing adequate housing for personnel in transit. This task included the establishment of a transient village named "All American Square." The village featured dining options, laundry facilities, MWR resources, transfer facilities, and a cargo area. Construction began January 2010. In May, All American Square was occupied by troops while still under construction. The village was located in close proximity to the passenger terminals for the convenience of the population in transit. The construction of the village was gratifying for members of the 557th ERHS who viewed the project as contributing to sending troops home. Capt. Jeffery Brandenburg, who served as chief of construction with the 332d ECES, explained the need for the village,

> What we discovered was that we had Soldiers, Sailors, Airmen and Marines stacked on top of each other due to overcrowding in the terminal, which is rather unfair after a hardship tour…so, we created the lounge with the expectation that this would give an area for overflow passengers to relax, grab a bite to eat, watch some TV, and use the wireless Internet, so they're not sleeping on the floor.[755]

These simple provisions were appreciated by the troops.

After more than seven years of combat operations, the last elements of the 557th ERHS departed Iraq on August 20, 2010. At the end, the 200th and 201st RED HORSE Squadrons were the primary units of the 557th ERHS as it left Iraq. These two units were part of the initial activation of the 557th ERHS back in 2005. At the peak of operations in Iraq there were 500 RED HORSE personnel deployed providing engineer support to approximately 20 FOBs throughout Iraq. They completed over 100 major construction projects valued over $60M.[756] The last U.S. Air Force civil engineers left Iraq in December 2011.

Contingency Innovations

As in most combat situations, field conditions in Afghanistan and Iraq resulted in the development of a variety of equipment innovations for Air Force civil engineering operations. Beddown packages typically comprised Harvest Eagle and Harvest Falcon assets. Among the technological changes was the adoption of new beddown packages. The Air Force Special Operations Command (AFSOC) civil

U.S. Air Force Civil Engineers Killed in Action following September 11, 2001

A total of 23 Air Force civil engineers lost their lives in the line of duty between 2001 and 2012. This included a firefighter, a heavy equipment operator, an engineer officer, an EOD officer, and 19 enlisted EOD personnel. Each have been honored in a variety of methods, including buildings, streets, highways, and rooms named in their memory. Numerous bases established memorial plaques or displays with the names and photos of the 23 fallen warriors to honor their service and keep their memory alive.

Operation Enduring Freedom

MSgt. Evander Earl Andrews	October 10, 2001	Al Udeid AB, Qatar
Maj. Rodolfo Rodriguez	September 20, 2008	Islamabad, Pakistan
TSgt. Phillip A. Myers	April 4, 2009	Helmand Province, Afghanistan
SSgt. Bryan D. Berky	September 12, 2009	Bala Baluk, Afghanistan
TSgt. Anthony C. Campbell, Jr.	December 15, 2009	Helmand Province, Afghanistan
TSgt. Adam Kenneth Ginett	January 19, 2010	Near Kandahar, Afghanistan
SrA. Michael J. Buras	September 21, 2010	Kandahar, Afghanistan
SrA. Daniel Johnson	October 5, 2010	Kandahar, Afghanistan
TSgt. Kristoffer Solesbee	May 26, 2011	Kandahar, Afghanistan
SSgt. Joseph Hamski	May 26, 2011	Kandahar, Afghanistan
TSgt. Daniel L. Douville	June 26, 2011	Helmand Province, Afghanistan
SrA. Bryan R. Bell	January 5, 2012	Helmand province, Afghanistan
TSgt. Matthew S. Schwartz	January 5, 2012	Helmand province, Afghanistan
A1C. Matthew R. Seidler	January 5, 2012	Helmand province, Afghanistan

Operation Iraqi Freedom

SSgt. Ray Rangel	February 13, 2005	Balad, Iraq
TSgt. Walter Moss, Jr.	March 29, 2006	Baghdad, Iraq
MSgt. Brad A. Clemmons	August 21, 2006	Taji, Iraq
Capt. Kermit Evans	December 3, 2006	Al Anbar Province, Iraq
TSgt. Timothy R. Weiner	January 7, 2007	Baghdad, Iraq
SrA. Elizabeth A. Loncki	January 7, 2007	Baghdad, Iraq
SrA. Daniel B. Miller, Jr	January 7, 2007	Baghdad, Iraq
SrA. William N. Newman	June 7, 2007	Balad, Iraq
TSgt. Anthony Capra	April 9, 2008	FOB Paliwoda, Iraq

engineers began development of a new deployment package in 2001. The package was designed to be a “right-sized deployment” kit to provide troops with basic quality of life functions. Col. Ed Keith, the AFSOC civil engineer, explained the concept, “When we went to war, we found out that our guys were getting there earlier than everybody else. We had nothing to give our warriors so they operated out of their aircraft. They had no place to sleep, no latrines; they had absolutely no structure.”[757] The answer to the dilemma was the Air Rapid Response Kit (ARRK). The ARRK provided equipment and assets for smaller units who first arrived at a deployed site or were ordered beyond the lines. The kits provided enough equipment and supplies to maintain the deployment until the arrival of the initial forces and the bare base assets, Harvest Eagle and Harvest Falcon. Four options existed for the kits: ARRK to support 100 personnel, ARRK Lite for 50 personnel that could be assembled by combat/ ground troops, ARRK ST (special tactics) for 20 personnel, and ARRK Mini. The ARRK Mini was essentially a high-tech folding cot with a built-in tent, anti-bacterial hygiene cloths and a few chemical potty bags."[758] Each ARRK supporting 100 personnel comprised "military tents, commercial shower/shave unit, water bladder, diesel water heart, generators, expeditionary latrines, and ancillary assets such as housekeeping items, fire extinguishers and smoke detectors."[759] The ARRK was first used during OIF for the command and control area and as part of the beddown at Diyarbakir, Turkey.[760]

In 2002, war reserve materiel (WRM) assets were streamlined to make deployments easier on troops and consistent with the Air Force expeditionary force concept. Harvest Falcon and Eagle assets were modified for ease of assembly. The Air Force expeditionary concept became the Basic Expeditionary Airfield Resources (BEAR). BEAR assets were comprehensive kits designed to accommodate all deployment locations. The Swift BEAR set supported 150 persons for the outset of a bare base. The BEAR 550 Initial set supported 550 personnel at a bare base and could be expanded through the addition of the BEAR 550 Follow-On set, BEAR Industrial Operations Set, and BEAR Flightline Set.[761] Five years after the BEAR concept originated, the BEAR Order of Battle evolved. The system divided the BEAR packages into smaller modular units. Specific parts could be ordered rather than the entire BEAR package. Partial package assets were lighter, more easily transported, and supplied only the necessary items to Air Force civil engineers.[762] The 49th Materiel Maintenance Group (MMG) was the only Air Force unit with the mission to "advise, assist and train deployed units" on the operation and maintenance of BEAR assets. During OEF, the 49th MMG deployed eight units to SWA; sixteen units were deployed during OIF. The teams assisted in beddown operations at Kirkuk AB, Tallil AB, and Baghdad International Airport.[763]

AMC tested a new structure developed by the Army in 2001. The Transportable Collective Protection System (TCPS) protected deployed service members from contact with airborne chemicals. The TCPS was a 96-foot "expandable TEMPER tent with a special protective lining and a powerful air

An EOD technician prepares a Talon robot before sending the robot to inspect a possible improvised explosive device.

management plant…[which] over-pressurizes the inside of the tent with filtered air so that airborne contaminants cannot penetrate the outside lining."[764] The system provided a safe environment for servicemen while stationed in an area of potential chemical attack. The TCPS could accommodate any function including personnel shelters, dining and medical facilities. AMC maintained twelve TCPS units at McGuire AFB.[765]

Robots became critical tools for EOD personnel to address the evolving hazards of explosives handling in Afghanistan and Iraq. The Bombot allowed team members to safely countercharge IEDs from a distance. The All-Purpose Remote Transport System (ARTS) with attachments was used to clear buried ordnance and minefields. The Remote Ordnance Neutralization System was developed as a remotely controlled bomb disposal robot. Other robots utilized by EOD included the Pacbot, a joint-service developed machine; the MACV, a Danish-designed robot for mine clearance; and, the Talon.[766] In SWA, robots were used by EOD flight members to clear UXO at bases used during the first Gulf War. The ARTS cleared 2-feet of subsurface for 50 acres, which allowed the U.S. Army Corps of Engineers to safely construct new parking ramps.[767] In 2007, a new EOD vehicle was introduced. The Joint EOD Rapid Response Vehicle provided personnel with greater protection and improved technology than the traditional Humvee. It was outfitted with optical cameras and infrared technology.[768]

Energy conservation became a major concern at expeditionary locations because of the cost in dollars and lives to purchase and transport fuel in Iraq and Afghanistan. A reduction in electricity at deployed locations meant less fuel was needed to operate generators and fewer fuel trucks on the road. In 2008, AFCESA and the AFRL evaluated the feasibility of installing solar flys over tents used with BEAR assets. The following year, the BEAR program funded the Air Force's involvement in the Net Zero Plus Joint Capability Technology Demonstration. The focus of the demonstration was to "reduce fuel consumption at forward operating bases and expeditionary bases."[769] Results of the demonstration were shared among the military branches. The goal of the Air Force was to implement a Solar Integrated Powered Shelter System that increased "energy efficiency by fifty percent and generates at least 3 kW of solar power."[770] Other energy programs for use at expeditionary bases were the Integrated Smart BEAR Power System and the BEAR Power Unit. The Integrated Smart BEAR Power System was a smart micro-grid that used renewable energy sources. The BEAR Power Unit was an 800kW generator that used "an electronic computer-controlled fuel injection system."[771]

Other Military Deployments

Between 2000 and 2010, Air Force civil engineers were in high demand to support other U.S. Armed Services and Federal agencies in addition to assignments to support OEF and OIF. These other taskings ranged from repair, construction, and support projects on CONUS bases to overseas deployments. Some deployments were completed during rotational training on in-progress construction projects. Other deployments were in response to support specific taskings. ANG and Reserve civil engineers also participated in these types of deployments, often as part of their training requirements.

In February 2002, 15 members of the 219th RED HORSE Squadron from the Montana ANG deployed to Israel for approximately a month to perform construction work. This Exercise Related Construction project was ordered through the U.S. European Command. The purpose of the deployment was to erect a metal, 119 x 48-foot K-span structure and to repair concrete airfield taxiways at an Israeli air base. The K-span construction project required multiple skills, including carpentry, equipment operation, and mechanical work. The project provided both hands-on team experience for Airmen, and project and logistics experience for NCOs. Most materials and equipment were procured locally, which required coordination with the host country. The RED HORSE team was hosted by the Israeli military personnel and was exposed to the local culture, including the participation in the Sabbath dinners on Friday nights.[772]

Air Force civil engineers participated in Alaska Shield-Northern Edge 2005, the largest homeland defense/homeland security exercise conducted in Alaska. As part of an exercise scenario, Airmen from the 611th CES at Elmendorf AFB, Alaska, rapidly deployed to a small village west of Anchorage to set up a portable runway lighting system. The airfield was the only access into the village, and previously was only suitable for daytime use. The Airmen benefitted from the real world training experience, while the lighting system made possible 24-hour use of the field. The village qualified for the lighting system through the Rural Alaska Lighting Program.[773]

In 2007, the DoD Office of Military Commissions required the construction of a legal complex at Guantanamo Bay, Cuba, in which to conduct trials for detainees. A camp had been established at Guantanamo Bay to house detainees from the conflicts in Afghanistan and Iraq. The time frame for the delivery of the legal complex was compressed and did not accommodate the negotiation of an outside contract. DoD requested assistance from the Air Force civil engineers. Ongoing deployments prohibited the assignment of an active duty RED HORSE squadron to the task, but the National Guard Bureau volunteered for the project. ANG civil engineers from the 122d CES from Fort Wayne, Indiana, led the project. Five other ANG units joined the team: the 121st CES from Columbus, Ohio; the 128th CES from Milwaukee, Wisconsin; the 150th CES from Albuquerque, New Mexico; the 158th from South Burlington, Vermont; and, the 163d CES from March ARB, California. These ANG units were constituted into the 474th Expeditionary CES attached to Davis-Monthan AFB, Arizona. Civil engineers from the 823d RED HORSE Squadron at Hurlburt Field, Florida, developed the construction designs. The construction unit, comprising members from the ANG Prime BEEF teams and a RED HORSE design team, were known as the “red bulls.”[774]

The advance party arrived at Guantanamo Bay in July 2007. The party surveyed the proposed site of the legal complex, a former airfield overgrown with tall grass and small trees. After the site work was completed, the team began construction on July 25. Forty shipping containers of materiel were delivered to the site. In all, 150 structures were built, including a courthouse, 15 administrative support facilities, and the tent city to house 500 persons. The first phase of work focused on the construction of a tent city using BEAR assets to house the expeditionary forces. Water, sewer, and waste disposal services were coordinated with the Guantanamo Naval Station. The tent city was completed by August 2007. The second phase of work involved the construction of the courthouse and legal support buildings. This construction commenced on September 11, 2007 and was completed to 100 percent of the initial design requirement in January 2008.[775] ANG civil engineers were assigned in rotations to complete the initial construction work. They continued the rotation schedule to sustain and maintain the complex, as well as complete additional construction work, as needed.[776] Lt. Col. James Starnes, 122d CES, summarized the unusual parameters of the project:

“Red Bull” civil engineers from the 474th Expeditionary Civil Engineer Squadron construct facilities at Camp Justice, Guantanamo Bay, Cuba.

> The Camp Justice legal complex was a unique collaborative effort. It was a DoD/Office of Military Commissions project; designed by active duty Air Force engineers from Hurlburt Field in Florida; managed by United States Southern Command, located in Miami; supported financially by United States Army South out of San Antonio; and constructed by ANG engineers from six different states on a United States naval base operated by civilian contractors, located in a communist island country.[777]

Humanitarian and Training Deployments

Humanitarian deployments for Air Force civil engineers were ongoing throughout the first decade of the twenty-first century. The civic action projects in Micronesia continued. Humanitarian projects incorporated the strategy for winning the war on GWOT. Other projects were completed to satisfy training requirements, primarily for ANG and Air Force Reserve personnel. Still other humanitarian projects were emergency responses to devastation resulting from natural disasters.

Combined Joint Task Force-HORN OF AFRICA

The Combined Joint Task Force (CJTF)-HORN OF AFRICA (HOA) under U.S. Central Command was a humanitarian component of OEF. The initial purpose of the CJTF was to track Al Qaeda activity in the area, to eliminate safe havens for violent extremist terrorists, and to build enduring regional partnerships to strengthen the countries in East Africa. The program was active in the countries of Kenya, Somalia, Ethiopia, Sudan, Eritrea, Djibouti, Uganda, Tanzania, and Seychelles. The humanitarian project was established by the U.S. Marine Corps on October 19, 2002 in Camp Lejeune, North Carolina. In November 2002, Marines embarked aboard the *U.S.S. Mount Whitney* to the Horn of Africa. The participants worked from the ship until May 2003, when the mission moved ashore to Camp Lemonier in Djibouti. From the beginning, the CJTF-HOA included representatives from all U.S Armed Services. The humanitarian portion of the mission was to build and renovate schools, medical clinics, and hospitals. Medical Civil Action and Veterinary Civil Action projects also were conducted.[778]

Thirty-six members of the 823d RED HORSE Squadron deployed to Camp Lemonier in July 2004 for a period of 180 days. Projects accomplished by the team were the repair of 35 km of gravel road and construction of a 45-foot concrete culvert bridge and concrete ford crossings. Other team members were sent to northern Ethiopia to renovate military billets for the Guam National Guard, which was training the Ethiopian Army. The RED HORSE team constructed latrines, hot water showers, and a water storage structure, and installed a backup electrical generator. At the same time, the team erected a 1,000 square-foot medical clinic in a nearby village. The team constructed a 3,000 square-foot school in a second isolated village. In southern Ethiopia, another team renovated and repaved the decking of a 12 x 400 foot bridge that served a population of 200,000. Team members also built a corral to support a future veterinary civil action program. RED HORSE team members conducted airfield pavement assessments in Kenya, Ethiopia, and Djibouti. Throughout the deployment, RED HORSE team members worked with members from other U.S. Armed Services, as well as military in the host countries.[779]

Between September 2003 and March 2005, 1,000 U.S. military personnel from all U.S. Armed Services staffed the CJTF-HOA. Projects included renovating 33 schools, 8 clinics, and 5 hospitals; digging 11 wells; and, conducting approximately 40 veterinary clinics. In August 2005, the workforce numbered 1,600 and included active duty, Guard, and Reserve personnel. In 2008, CJTF-HOA was transferred to the newly established U.S. Africa Command. By late 2009, emphasis on counter-terrorism activities decreased while support to partner countries increasingly focused on building in-country military and security capacity and undertaking civil-military humanitarian projects.[780] Between 2007 and 2010, the CJTF-HOA participants completed 285 humanitarian projects valued at $24.3 million. The projects included 146 educational, 77 medical, and 62 essential services projects. Essential services encompassed well and water projects, community services, disaster response, and delivery of humanitarian assistance supplies. Countries served included Djibouti, Ethiopia, Tanzania, Uganda, Kenya, and Islands of Comoros.[781]

Civic Action Teams

Formally-constituted Civic Action Teams supported the U.S. national treaty commitment to Micronesia through 2003.[782] The deployment combined economic development and humanitarian projects with training in a remote international environment. Every six months, the Air Force deployed a 13-member team to Truk Island. Every 12 months, a team was deployed to Pohnpei. The teams provided technical assistance and training in maintenance skills. The teams comprised an officer-in-charge, an assistant officer-in-charge, three structural specialists, two pavements and construction equipment operators, one utilities specialist, one electrician, one independent medical technician, one supply specialist, and two vehicle mechanics. While deployed, each team trained local apprentices, completed construction projects, conducted community relations programs, and provided technical assistance.[783] Team members were selected from throughout the active duty civil engineer ranks from bases and from FOAs.[784]

CAT 02-01 was assigned to the Truk Island between October 2001 and May 2002. CAT 02-01 completed the following projects: renovation of a hospital pediatrics ward, road maintenance, new road construction, renovation of electrical systems in a government administration building and a school, maintenance of HVAC equipment, distribution of potable water, and vehicle maintenance. The medical technician provided medical support for the team members, as well as training to local health care workers. Medical care was received by 1,000 people on the main island and surrounding outer islands. CAT also provided emergency assistance. When tropical storm Chata'an struck the island, the team supported the local residents by pumping water from flooded homes. The team served as the local liaison for the Federal Emergency Management Agency (FEMA) for the receipt of relief supplies. In the 15 days following the storm, CAT members off-loaded more than 500,000 pounds of supplies from twenty-eight C-130 aircraft. The team members also distributed food, water, blankets, and other needed supplies.[785]

Following the 2003 conclusion of the CAT program in the Federated States of Micronesia, Air Force teams began serving in the Republic of Palau under the U.S. Pacific Command (USPACOM) in partial fulfillment of the U.S. Compact Treaty. In October 2004, CAT 05-01 arrived at Camp Katuu in the Republic of Palau for a six-month tour of duty. The team's purpose and structure were similar to earlier CATs. The 13-person team comprised nine Air Force civil engineers, two vehicle mechanics, one supply technician, and one physician assistant. The team members were chosen from bases throughout the Air Force. A major task for CAT 05-01 was the construction of a 40 x 60 foot pre-engineered police and fire emergency building at Melekeok village. Team members also performed electrical repairs in such buildings as schools. CAT members mentored local residents as trade apprentices.[786]

CATs continued to be deployed throughout the decade. By 2009, responsibility for the Palau CAT program was moved to the Fifth Air Force. Program administration was maintained by the 36th CES stationed at Anderson AFB, Guam. Selection for the CAT teams was competitive and application was open across the entire Air Force. The goals of the mission as defined in 2009 were:

1. Maintain a favorable presence in support of the USPACOM Theater Security Cooperation Plan
2. Assist and train the local population in engineering, administrative, and medical skills
3. Provide construction support to the Republic of Palau in their [sic] basic infrastructure development.[787]

In 2009, the CAT members worked on three USPACOM-funded projects. One project was a medical clinic with a reception area, two examination rooms, a laboratory, a pharmacy, and a restroom. The second project was a restroom facility for an isolated elementary school located on a small island that was a three hour boat trip from the base camp. The third project was a 2,400 square-foot, pre-engineered building to house emergency services on the Palau's largest island. The building was designed to match a similar building constructed by a CAT in 2005.[788]

Deployment for Training

The deployment for training program was scheduled each year to meet the two-week Reserve and ANG training requirement. The purpose of deployments was to provide real world training opportunities for AFRC and ANG civil engineers outside the limited construction opportunities found at their home bases. Deployment for training projects included a wide range of activities, including deployments to remote areas to support humanitarian efforts, specific construction projects for the major commands, and participation in joint task forces. These training opportunities allowed civil engineers to hone their skills, enhance competency, and work with military personnel from other U.S. Armed Services. Those who deployed to other countries through the deployment for training program were also exposed to new environments and host nations.[789]

The identification of appropriate projects was a joint effort involving the AFRC, the ANG, and AFCESA. AFCESA contacted the major commands to identify training opportunities, while AFRC and the ANG polled the Reserve units about their training needs. Matching opportunities with training needs was a complicated process that required full-time support. A critical path for finalizing training deployments was identifying the transportation requirements to the training sites. Ongoing programs routinely supported by ANG and Reserve units were the New Horizons and the Joint Task Force Para Los Ninos programs, which were organized by the Twelfth Air Force for USSOUTHCOM. Another program overseen by the Secretary of Defense was the Civil-Military Innovative Readiness Training Program.[790] Supporting construction at major commands also became training opportunities; these projects were particularly useful in maintaining home bases while active duty civil engineers were deployed.

Nuevos Horizontes/New Horizons

New Horizons was an ongoing annual program that combined humanitarian civic action and training opportunities. Headquarters, U.S. Southern Command (USSOUTHCOM) administered the program, which aided countries in the Caribbean, and Central and South America through the construction of infrastructure and through medical support. Projects typically included the construction of medical clinics, schools, and water wells. The program was structured to include components from all U.S. Armed Services and often military units from the host countries. The Twelfth Air Force oversaw Air Force participation in the program.

New Horizons 2001 sent U.S. military teams to Guatemala, Honduras, Paraguay, Saint Lucia, Saint Vincent, and the Bahamas. Air Force civil engineers participated in projects in Saint Lucia, Guatemala, and Paraguay. In Saint Lucia, members from the 820th RED HORSE Squadron from Nellis AFB, Nevada, deployed with Army and Marine personnel to construct a two-story barracks for the St. Lucian Coast Guard. The group also renovated a local community center. In Guatemala, members from Detachment 1, 307th RED HORSE Squadron deployed to construct the base camp for the mission. Members of the 820th RED HORSE Squadron deployed to lay the concrete foundations for five schools. Follow-on teams included the reserve 917th CES from Barksdale AFB, Louisiana, which completed a concrete-block school. The new school building encompassed a classroom, kitchen, and restrooms. In Paraguay, projects included the construction of two medical clinics and four school buildings and the drilling of four wells. Members from the 823d RED HORSE Squadron worked with Army and Marine engineers and members of the Argentine and Paraguayan military forces. In all, the joint and combined task force comprised 300 engineers, medical, and support personnel. The entire project spanned 100 days.[791]

During 2002, New Horizons projects were completed in Nicaragua and Jamaica. In February 2002, Air Force civil engineers participated in a project in Nicaragua known as Joint Task Force Chontales. Air Force units included the 507th CES (reservists) from Tinker AFB, Oklahoma; the 434th CES from Grissom Air Reserve Base, Indiana; active duty Army personnel; and, members of the 829th Engineer Detachment, Wisconsin Army National Guard. The goal of the two-week deployment for the 507th CES was to complete construction of hardback tents in the base camp begun by the U.S. Army. The base camp was designed to house future groups assigned to complete the humanitarian mission. Construction of the base camp was plagued by unseasonably wet weather, which turned the site, a former cow pasture, into a sea of mud. The 507th CES plunged into the mud to build the bare base camp. In twelve days, the unit completed construction of the camp hospital, mess, and dining facilities; built three latrines and a changing room and shower; constructed the commander's operational center; and, completed 22 tent pads and raised the hardback billeting tents. The team electrified the camp using 10,000 feet of electrical cable and installed 2,500 feet of water and wastewater distribution pipes.[792]

Teams from the 202d RED HORSE Squadron from the Florida ANG, the 200th RED HORSE Squadron from Ohio, the 201st RED HORSE Flight from Pennsylvania, and the 203d RED HORSE Squadron from Virginia, joined Joint Task Force Blue Mountain to construct a medical clinic for a local community and a barracks in Jamaica. The RED HORSE units worked alongside units from the Marine Corps and interacted with members of the Jamaican Defense Force. The members of the Jamaican Defense Force were grateful for the new barracks, which were electrified and climate controlled.[793]

In 2004, Honduras was one site for New Horizons projects. Members of the 934th CES, a Reserve unit located at Minneapolis-St. Paul International Airport, were deployed to Saba, Honduras. This group established the base camp, which was used throughout the summer by other teams to complete the construction of schools and medical clinics. This group repaired roads, set up tents, installed airfield and perimeter lighting, and connected water to portable latrines and showers. The team also poured concrete pads for the humanitarian projects that were accomplished by later incoming teams. All team members enjoyed the work and helping others.[794]

Between January and June 2005, approximately 3,500 Army and Air Force Reservists participated in New Horizons 2005. Projects occurred in Panama, El Salvador, and Caribbean countries.[795] El Salvador suffered an earthquake in 2004 and Air Force civil engineers assisted in rebuilding schools and clinics.[796] The 507th CES Air Refueling Wing from Tinker AFB, Oklahoma, participated in Joint Task Force Para Los Ninos (for the children) in El Salvador. From February 11 until May 7, 54 members of the 507th CES worked in six, two-week rotations to build a new three-room school. One group laid the concrete foundation, while the next group started construction of the walls. At the end of four weeks, the foundation, water supply, sanitation system, and six courses of concrete block were completed. The school was completed by June. The squadron also completed a playground, made minor repairs on the old school, and donated $250 worth of school supplies.[797]

In 2007, nearly 250 military personnel, led by the 820th ERHS participated in the New Horizons-Nicaragua 2007 "Juntos Podemos," meaning "together we can." Members from the 820th ERHS arrived in late December 2006 to begin planning the projects and laying out the base camp. The camp was established in time for the arrival of 800 tons of equipment. The camp accommodated the following facilities: billeting, offices, kitchen, laundry, shower/shaves, vehicle maintenance, supply, fitness center, and a helicopter landing pad. The base camp was shipped in seavans, vehicles, and slingable-container units. Materials for the actual construction projects were purchased in Nicaragua. Projects completed as part of this $7.5 million humanitarian and training exercise included construction of a three-room school and a five-room medical clinic, repair of 44 miles of roads, repair of one water well, and drilling of two new water wells.[798]

In 2008, the program was renamed Beyond the Horizon.[799] During one project in 2008, members of the 820th RED HORSE, the 555th RED HORSE, and the 219th RED HORSE Squadrons led a task force to Peru. Projects included construction of a school and a medical clinic at Panama, and a medical clinic in San Cristobal.[800] In 2009, nearly 650 Army, Navy, Marines, and Air Force personnel deployed to Guyana. Work in Guyana included the construction of a new medical clinic and a school house, and the renovation of a second school house. The team included U.S. military medical personnel, who conducted five medical clinics and two dental clinics.[801]

Innovative Readiness Training (IRT) Program

Begun in 1996, the focus of IRT was "Americans helping America." In 2004, 14 IRT projects were fielded. Most projects assisted Native American groups.[802] In 2006, 150 Reservists from Oregon, Maryland, and Ohio worked in two-week rotations for 12 weeks at the Washoe Indian Reservation near Carson City, Nevada. Construction projects included the completion of a 5,100 square-foot early childhood education building. Work included interior finishes and the installation of electrical systems, kitchen equipment, bathrooms, and classrooms. The Reserve civil engineers also constructed sidewalks and a playground. Other projects included the conversion of a 2,100 square-foot former convenience store into a tribal wellness center, paving a parking lot, and building a home for an elderly, handicapped tribal member.[803]

In 2007, 100 IRT projects were selected. In May 2007, 22 civil engineers from the 301st CES, Naval Air Station, Joint Reserve Base Fort Worth, Texas, deployed to Oahu, Hawaii, to build homes for the disabled and elderly. This marked the second year that the AFRC had participated in an IRT project with ORI Anuenue Hale (Rainbow House), a local non-profit group. In 2006, the Air Force Reserve constructed three, five-bedroom homes. During their two week training deployment in 2007, the 301st Fighter Wing CES installed a fence, framed three cabins, installed ten street lights, set up and converted a trailer into an office, set up a supply tool system, and installed a water line.[804]

Exercise Tropical Hammer

In March 2009, members of Oregon ANG's 142d CES participated in the Canadian-hosted Exercise Tropical Hammer, a multi-national training exercise in Kingston, Jamaica. The project was conducted in cooperation with the Jamaican Defense Force. Members from four countries participated in the exercise, including a unit from England. The purpose of the deployment was to convert metal storage pods, known as "conex boxes," into classrooms, a trade school, and a counter-terrorism school for the Jamaican Defense Force. Challenges in the construction were the heat and humidity, inferior tools, and a shortage of supplies. However, the training opportunity afforded participants a chance to acquire new skill sets and to participate in assignments beyond their normal daily routine.[805]

Base-to-Base Deployments

In 2003, members of the 819th RED HORSE Squadron from Malmstrom AFB, Montana, deployed to Ellsworth AFB, South Dakota, to construct a new Base Information Transfer Center. The center received and distributed all incoming mail to the base and required a stand-alone building apart from inhabited areas as a force protection measure. The building measured 44 x 70 feet and included containment rooms for handling possible explosive devices and materials suspected of chemical and biological contamination. The original design called for 12-inch thick walls constructed of concrete masonry units, but the RED HORSE received approval to use insulated concrete forms instead. This innovation expedited the construction project.[806]

In 2004, the 124th CES of the Idaho ANG sent 37 members on a two-week training deployment to the former Ramey AFB, Puerto Rico. The former Air Force base was occupied by the U.S. Coast Guard, which operated approximately one-fifth of the base. With manpower and budget cuts, the Coast Guard requested Air Force civil engineering construction and maintenance support through the National Guard Bureau. The National Guard Bureau utilized this request as an opportunity for a real world training project. Construction projects completed by the ANG crew included the installation of new windows and electrical outlets in a child care center, demolition and construction of walls in a maintenance hangar, HVAC and electrical installation, and cyclical maintenance for several facilities.[807]

In the Republic of Korea, the 554th RED HORSE Squadron completed a series of construction projects at air bases with the help of 170 RED HORSE personnel. In 2006, active duty, ANG, and Reserve personnel were drawn from the 307th RED HORSE Squadron at Barksdale AFB, Louisiana; the 555th and 820th RED HORSE Squadrons at Nellis AFB, Nevada; and, the 254th CES from Andersen AFB, Guam. Some personnel deployed for their two week training requirement, while others stayed longer. Construction projects included replacement of the aircraft arresting systems, road construction, installation of drainage culverts, and construction of buildings to contain the aircraft arresting systems at Kunsan AB. At Kimhae AB, two steel-arch warehouses were constructed to store war reserve materiel. In addition, 30 contingency cabins were built to support air force expeditionary rotations. At Suwon AB, a new latrine and laundry facility was constructed.[808]

<u>Other Humanitarian Deployments and Responses</u>

Air Force civil engineers also were deployed as members of other humanitarian projects. In 2001, 41 members from the 176th CES Alaska ANG, and 35 members from the 157th CES from the New Hampshire ANG worked together to construct a new school in the village of Pacoche en Medio in western Ecuador. The project required construction of a two-room school, a home economics building, a water storage tower, and a latrine system for the village. In four weeks, the engineers mixed more than 55 cubic yards of concrete and 2 cubic yards of stucco, and shoveled 15 cubic yards of rocks and 10 cubic yards of sand. The project required laying over a thousand concrete blocks and installation of 2,100 square feet of metal roofing. The project was completed despite challenges. Wet weather delayed work on the concrete foundation, which had been scheduled for completion by local contractors prior to the arrival of the first team. Instead, the first team assisted in pouring the foundation. Heavy rains blocked the road to the construction site during the rotation of the second team. This team hiked 3.5 miles to the site in order to complete the work. Other challenges included a lack of heavy equipment, such as a concrete mixing truck. Concrete was mixed by hand. The manual labor was strenuous and accomplished in average 85-90 degree heat. All participants noted the friendliness and gratitude of the local villagers and agreed that the effort was worthwhile.[809]

From August to December 2008, 40 Airmen and 20 Navy Seabees commanded by Maj. Thomas DeFazio of the 5th CES from Minot AFB, North Dakota, set sail on the *U.S.S. Kearsarge* as members of Operation Continuing Promise (08). The purpose of the sea-based operation was to visit countries in the Caribbean and to provide joint humanitarian and civic assistance. The nations scheduled for visits were Nicaragua, Colombia, Curacao, Guyana, Trinidad and Tobago, and the Dominican Republic. Operation Continuing Promise was the vision of SOUTHCOM Commander Adm. James G. Stavridis to demonstrate U.S. commitment to neighbors in the region. The purpose of the project was to

Air Force SSgt. Arthur Malecki makes repairs to a hospital in West Demarara, Guyana, as part of Continuing Promise 08.

improve health care and education, and to construct childcare centers and community buildings. Air Force civil engineers completed 23 projects in five countries. The team gained experience in logistics, naval engineering operations, and life aboard ship. The projects included construction of three new schools, renovation of five schools, renovation of five medical clinics, ten recreation projects, and five infrastructure repairs. An unscheduled stop was made in Haiti to provide disaster relief from the effects of three devastating storms. Air Force civil engineers assisted in conducting 15 bridge assessments, surveying 450 miles of roads, and restoring a 2,000 foot water pipeline in a remote village. "CP08 provided our engineers with training, cross-training, and a service-to-service exchange of expertise," wrote Major DeFazio.[810]

When a devastating 7.0 magnitude earthquake struck Port-au-Prince, Haiti, on January 12, 2010, Air Force civil engineers were among the first responders. Within 24 hours, civil engineers from the Air Force Special Operations Command at Hurlburt Field, Florida, were deployed to the Toussaint L'Ouverture International Airport in Port au Prince. The civil engineer team specialized in rapid bed-down of the Air Rapid Response Kit (ARRK) to support small unit operations. The initial tasks were to secure the airport, to set up a joint operations center, and to construct the ARRK beddown package to house 280 joint military staff. The civil engineers helped to restore airport operations and supported airfield security, evacuations, humanitarian airdrops, communications, and logistics. Members from the 820th RED HORSE Squadron were in the country by February 2010 to help implement the Government of Haiti's safer shelter strategy. RED HORSE members assisted in identifying persons for relocation to government camps and then assisted with the planning and construction of those camps. The civil engineers also worked on projects to mitigate flooding and landslides; these projects included clearing debris from drainage canals to prevent flooding during the rainy season.[811]

Air Force civil engineers also worked to be good neighbors in their communities. During 2000, members of the 423d Air Base Squadron from RAF Alconbury, England, volunteered for Habitat for Humanity to build houses in London's Southwark borough. Organizers of the Habitat for Humanity project were delighted when Air Force personnel arrived. The organizers described their needs and provided house plans. The Air Force civil engineers took it from there. The Air Force civil engineers benefitted from the hands-on work required at the construction site and added professional knowledge to the volunteer labor pool.[812]

Disaster Response in the United States and at U.S. Air Force Bases

Air Force civil engineers are responsible primarily for operating and maintaining bases. When emergency situations arise, Air Force civil engineers mobilize quickly to protect CONUS and overseas Air Force bases.

Between August 24 and 27, 2000, 23 inches of rain deluged Kunsan AB in the Republic of Korea. The 8th CES activated the damage control center as base facilities began to flood. Flooding occurred in many operational buildings, the theater, the food court, and recreational buildings. Facilities that did not flood developed leaks. Base civil engineers fixed leaks and operated suction pumps to drain water out of the buildings. In addition, Air Force personnel responded to a request for assistance from Kunsan City to reopen a major four-lane highway between the city and the air base. Air Force civil engineers teamed with the Republic of Korea army to remove a mudslide from a highway. The 8th CES contributed personnel and the use of three front-end loaders and two dump trucks to support the removal of 2,600 tons of mud, concrete, and debris from the highway.[813]

Air Force civil engineers at Randolph AFB, Texas, weathered drought, a well contamination, and flooding during summer 2001. In July, drought conditions taxed the base potable water system. On August 2, residents reported a dark syrupy substance coming out of faucets in the housing areas. This was traced to one well contaminated with petroleum fuel. Water was trucked in for base residents and employees; base firefighters relied on water supplied by nearby communities through mutual aid agreements. Remediation required flushing the entire water system, including the water towers and water mains. The pressure from flushing the system burst many aged pipes, requiring the repair of ten water mains and the replacement of 10,000 feet of pipe within 72 hours. Base plumbers from the 12th CES were augmented by plumbers from the 37th CES from nearby Lackland AFB. Repair teams included personnel from the 37th CES, the 307th RED HORSE Squadron, and the San Antonio Water System. Contracts were prepared and awarded by dedicated base contracting personnel. AFCEE provided expertise on the aquifers and ground water wells. By the following Tuesday, non-potable water was restored to the base. One week later, Randolph AFB experienced torrential rain that resulted in the flooding of several facilities, downed tree limbs, and debris on the roads. The civil engineers from the 12th CES pumped water from flooded facilities, removed debris from roadways, and cleared away tree limbs.[814]

On July 5, 2002, Typhoon Chata'an struck Andersen AFB in Guam. The 100 mile-per-hour winds knocked out electrical power and damaged transformers and switch boxes. The typhoon also damaged base buildings. By July 12, 20 members of the 15th CES from Hickam AFB, Hawaii, and 6 members from the 3d CES from Elmendorf AFB, Alaska, arrived to augment the 36th CES at Andersen AFB. The new arrivals brought eight electrical generators, seven portable air conditioning units, ten ice machines, additional electrical wiring, and other essential supplies. Two staff personnel sent from Headquarters, PACAF, and one CEMIRT staff member traveled to the base. The initial focus for the team was to restore power to living quarters by reconfiguring electrical wiring. This was accomplished by July 13. Restoration of electricity to the entire base and quality assurance of the electrical system followed in the next few days.[815]

In May 2003, nature provided an exercise in disaster preparedness and base recovery at Tinker AFB, Oklahoma. On May 8, a F4-force tornado struck Tinker AFB. With winds from 150 to 260 miles-per-hour, the tornado resulted in estimated damage of more than $10 million. The damage estimates included the total cost of the impact, cleanup, and repair/replacement. The team responded appropriately and efficiently to the situation. Security forces directed personnel to storm shelters. After the tornado, the fire department and engineering operations personnel immediately conducted damage assessments and implemented recovery measures. The base civil engineers quickly assessed the damage, replaced base security fencing, and restored electrical power. "It was an outstanding effort on everyone's part," said Base Civil Engineer Stephen Mallott.[816]

Hurricane Isabel struck the east coast of the United States on September 19, 2003. Langley AFB, Virginia, was the hardest hit AFB, although several bases were in the storm's path. Damage was sustained by 121 buildings and structures. This damage primarily involved roofs. Mature trees, many of which dated from the permanent development of the base following World War I, were the hardest hit asset on base. Downed trees numbered 800 on the main post, 300 on the golf course, and 140 trees in an off-post housing area. Lt. Col. Richard Wheeler, commander of the 1st CES at Langley AFB, said "Langley's landscape was noted for its large shade trees and you can't imagine the way the base looked after the storm passed."[817] Civil engineers from Langley AFB and Shaw AFB, South Carolina, and 823d RED HORSE Squadron from Hurlburt Field, Florida, began the cleanup. Damage assessments were completed, power was restored, and water was removed from flooded buildings. In addition, the downed and damaged trees were removed. CEMIRT members from Dover AFB, Delaware, assisted in restoring electrical power to the base, while CEMIRT members from Tyndall AFB, Florida, worked

1st Civil Engineer Squadron sweepers clear the large amount of debris left by the receding flood waters on the Langley AFB parking areas following Hurricane Isabel.

to restore heating, ventilating, and air conditioning services. The total damage to the base was estimated at $200 million. The AFCAP contract was accessed for $14.5 million to facilitate building and infrastructure repairs; pump water from flooded basements; procure carpet cleaning services; and, implement cleaning and sanitizing of water-damaged basements. Military families were allowed to return to their homes within three days and the flying mission resumed a week later.[818]

In August-September 2004, four major hurricanes struck Florida, resulting in damage to several AFBs and surrounding areas. Air Force civil engineers supported both base cleanup and recovery efforts in nearby communities. Patrick AFB was damaged by rain and winds from Hurricanes Frances and Jeanne. The 45th CES at Patrick AFB battled gale force winds to keep a vital generator operational. After Hurricane Frances, the CES quickly completed damage assessments. Damage estimates from Hurricane Frances were $32.7 million; several more millions of dollars in damage was sustained from Hurricane Jeanne. Hurricane Ivan caused $87 million worth of damage at Eglin AFB and another $40 million at Hurlburt Field. The hurricane caused heavy damage to the electrical system at Eglin AFB and members of the 796th CES worked with civilian electricians to restore power. Recovery work at Hurlburt Field was assisted by staff from AFCESA and 55 ANG civil engineers from 11 states, who worked alongside the 823d RED HORSE Squadron. Air Force civil engineers also extended a hand to community recovery efforts. Seventy members of the 202d RED HORSE Squadron assisted in cleanup efforts at the Charlotte County Airport, and then assisted to restore a residential retirement building to operability.[819]

On August 29, 2005, Hurricane Katrina slammed into the Gulf Coast and ravaged the area between Florida and Texas, inflicting significant damage in Mississippi and Louisiana. Hurricane Rita followed in September 2005. Immediately after Hurricane Katrina, Air Force civil engineers provided support to initial recovery efforts. Prime BEEF teams established BEAR camps at New Orleans International Airport, Louisiana, and at Gulfport ANG Combat Readiness Training Center (CRTC), Mississippi, to bed down 1,650 personnel. RED HORSE personnel deployed to Keesler and Columbus AFBs to aid recovery efforts. Prime BEEF teams were deployed to New Orleans, Louisiana, and Gulfport, Mississippi, to bed down the relief effort and assist evacuees. Lackland AFB, Texas, hosted 11,000 evacuees in transit to state and local reception centers.[820] In all, 1,300 civil engineers from ANG, Reserves, and active duty supported Federal recovery efforts in the aftermath of Hurricanes Katrina and Rita.[821]

Keesler AFB and ANG's CRTC in Mississippi were hard hit by Hurricane Katrina. Winds averaging 50 miles-per-hour with gusts up to 90 miles-per-hour knocked out electrical power. The storm surge produced a massive wall of water that inundated the coast. At Keesler AFB, flood waters covered the entire base. The base lost electrical power and many power poles were damaged. In the words of Lt. Col. Claudia Foss, the 81st Training Wing Public Affairs Office, a "good 95 percent" of Keesler AFB was damaged by the hurricane. Mud and debris were everywhere. Trees were downed. The industrial and housing areas exhibited drastic damage. Telephone and communications systems were not operational.

Recovery efforts began immediately after the storm. About 6,000 base personnel weathered the storm in seven shelters on base. Keesler AFB staff was directed to treat the base "like a deployed environment." Airmen worked around the clock, seven days a week to bring the base back online. Commanders of nearby installations, such as Pensacola Naval Air Station, also supplied aid. An advance team of Airmen from the 823d RED HORSE Squadron from Hurlburt Field, Florida, arrived within 12 hours of the storm with emergency supplies and all supplies and equipment that they needed to deploy. Roads had to be cleared for the first team to reach the base. Once at the base, RED HORSE personnel conducted damage assessments and removed debris from base roads and operation areas.[822]

A nine-member CEMIRT arrived from Tyndall AFB, Florida, with three large trailer-sized, 500kW electrical generators, several smaller generators, and truckloads of cables and equipment. CEMIRT initially provided emergency electrical power to facilities, like the base lodging facility, to house the 6,000 people on the base. Shortly thereafter, power was supplied to the dining facility, student

Hurricane Katrina did extensive damage to Building 4422 at Keesler AFB, Mississippi.

dormitories, the community center, and portions of the medical facility. Five days after the storm, the local utility company restored the high-voltage transmission lines to the base substation and electrical power was restored.[823]

The runway at Keesler AFB was flooded. Once the flood waters receded, RED HORSE teams worked to clear the runway of debris and to restore operations. Members of AFCESA's airfield pavement evaluation team assessed runway damage. The runway initially was serviceable only for daytime use; runway lights and navigational aids were damaged. The 823d RED HORSE Squadron sent an emergency airfield lighting system to expand operations. By September 5, 2005, the runway was fully operational, and the base became a hub for the distribution of humanitarian aid throughout the region. C-17 Globemaster and C-130 transport aircraft were able to land to bring in supplies. Water, food, blankets, clothing and medical support were delivered through the base.[824]

Repairs to Keesler AFB from Hurricane Katrina amounted to $950 million. "After safety and critical infrastructure, recovering training was our next focus. It helped that our training facilities—many one-of-a-kind—came through the storm in good shape," said Lt. Col. Ray Mottley, the 81st CES Commander. Training activities began within three weeks after the storm. Much work was required to restore the base back to complete operation. The 81st CES began a three-year program to repair, modernize, and rebuild installation facilities. Emergency preparedness for the next storm was initiated. Eighty percent of the base's 1,820 family housing units were damaged by the storm or by the subsequent flooding. Planning efforts began immediately to repair 600 houses, demolish 800 damaged houses, and build 1,067 new units through AFCEE's Housing program. Construction began in 2007 and was completed in 2010. Another large renovation/construction project was undertaken at the base hospital, the second largest hospital in the Air Force. Other projects included a new base commissary, hangar, fire station, and multi-purpose services facility.[825]

SUMMARY

Throughout the first decade of the twenty-first century, Air Force civil engineers transformed their organizations and adopted new or expanded roles to serve the missions assigned to the U.S. Air Force in challenging and hostile environments. Air Force civil engineers served as Battlefield Airmen, airborne RED HORSE, and on joint task forces during the rebuilding of Iraq and Afghanistan. The 2008 *Air Force Civil Engineer Almanac* aptly characterized Air Force civil engineers as "warrior, professional and ambassador."[826]

During 2011, the drawdown of troops in Iraq was completed, but a surge of U.S. forces occurred in Afghanistan. On April 30, 2011, the hunt for Osama Bin Laden, the leader of Al Qaeda, ended with his death at a hideout in Pakistan. This event resulted in re-assessment of the role of U.S. forces in Afghanistan. Troop drawdowns coupled with an increasing call for budget austerity in the United States to lower the high national debt signaled another period of budget cuts and reorganization of DoD.

As The Civil Engineer Maj. Gen. Timothy A. Byers wrote to the Air Force civil engineering community at the end of 2010,

> I continue to be amazed with what you do every day. With our unique capabilities, backed by a long and proud heritage, we've led and supported a number of high impact missions on the home front, in the Southwest Asia area of responsibility (AOR) and around the world. Because of what we bring to the fight, we've earned the recognition and respect of our Joint and Coalition partners – you are simply the best!...I'm excited about what lies ahead in 2011, and am eager to start building toward new heights. And, as we move forward, I expect all civil engineers to be ready to "Build to Last and Lead the Change!"[827]

Whatever the future holds, Air Force civil engineers can adapt and know that

Engineers Lead the Way!

EPILOGUE

FORGING THE FUTURE
2012 AND BEYOND

On October 1, 2012, hundreds of people gathered inside Hangar 1610 on the former Kelly AFB, Texas, flightline to witness history being made when Maj. Gen. Timothy A. Byers, The Air Force Civil Engineer, presented a flag representing the new Air Force Civil Engineer Center to Mr. Joe Sciabica, the field operating agency's (FOA's) first director. The ceremony was the culmination of months of planning for the new organization and also its initial operating capability milestone. According to General Byers, the new FOA represented "more than an organizational change. We are witnesses to the debut of the next generation of installation and expeditionary support capability. We are forging the future of Air Force Civil Engineering today."[1]

Mr. Joe Sciabica addresses the audience at the AFCEC activation ceremony while Maj. Gen. Timothy A. Byers, Mr. Robert M. Moore, Mr. Terry G. Edwards, and Col. David L. Reynolds listen.

The rationale behind the Air Force Civil Engineer Center arose several years earlier from the Air Force's budgetary constraints and the need to make Civil Engineering more efficient. Civil Engineer Transformation began under Maj. Gen. Del Eulberg in 2007 as part of Program Action Directive (PAD) 07-02, *Implementation of Civil Engineer (CE) Transformation Plan*. Civil Engineer leaders believed the first round of Transformation would take about 10-15 years to implement throughout the career field, based on examples from private industry they had studied. However, when Secretary of Defense Robert Gates announced additional efficiencies in 2010, they recognized dramatic and accelerated additional changes would be required. The Air Force faced a $33 billion reduction over a five-year period. This was followed by the 2011 Budget Control Act, which required an additional $10 billion reduction each year for 10 years for the Air Force. Under Resource Management Directive 703, the Air Force was directed to reduce civilian manning to FY10 levels representing a decrease of 13,500 civilian positions across the Air Force, 1,600 of which were Civil Engineer civilians. Civil Engineer leaders realized they could not afford to continue "business as usual" and decided to find transformational ways to operate more efficiently and effectively and to do it much sooner than anticipated. After more than a year of work under strict nondisclosure agreements, General Byers announced Spirals 2, 3, 4 of Civil Engineering Transformation…Accelerated (CET-A) in November 2011.[2]

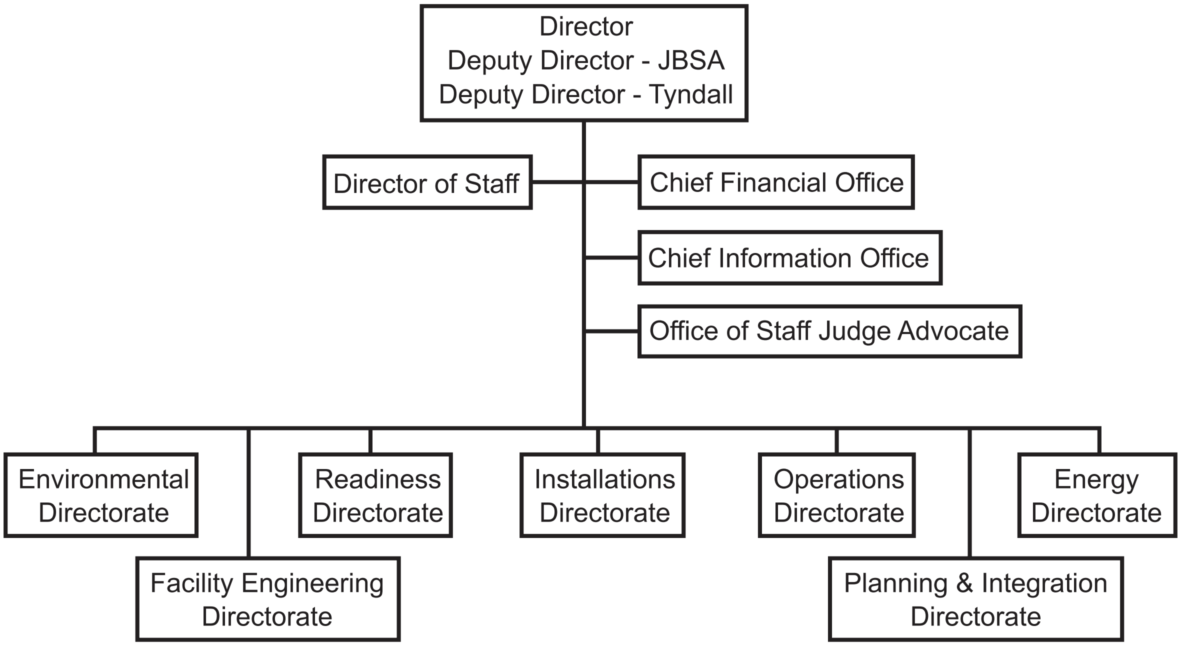
As formalized in PAD 12-03, *Implementation of Enterprise-Wide Civil Engineer Transformation,* CE Transformation…Accelerated comprised four spirals. Spiral 1 was the first phase of Transformation announced in 2007 and detailed in PAD 07-02. Spiral 2 streamlined and reduced manning at the Air Staff and consolidated three FOAs into AFCEC. This included the Air Force Civil Engineer Support Agency (AFCESA) at Tyndall AFB, Florida; the Air Force Center for Engineering and the Environment (AFCEE) at Port San Antonio, Texas, and the Air Force Real Property Agency (AFRPA), also located at Port San Antonio, Texas. The physical location of the three organizations did not change. Spiral 3 centralized major command Environmental Quality, National Environmental Policy Act Compliance, and Real Property management at AFCEC to provide more efficient support to major commands (MAJCOMs) and installations. Spiral 4 built upon Spiral 1's effort to reorganize Civil Engineer squadrons and called for transforming their programming, design, environmental quality and restoration capabilities, and realigning Operations flights and the Housing elements within the squadrons. This initiative reduced base-level authorizations by 968 civilian positions across the Air Force. However, to minimize risk, the Air Force reinvested 222 of those positions as part of AFCEC operating locations to support the installations. AFCEC used these positions to support centralized program management and provide execution oversight and overall facility planning and programming.[3]

Following Air Force lineage and honors guidance, the Air Force redesignated AFCESA as AFCEC because it had the oldest lineage. AFCEE and AFRPA were inactivated. Merging the three FOAs was not an easy process, especially with one at Tyndall and the other two in San Antonio. All three had different and distinct missions and cultures. Bringing them together was the responsibility of Mr. Joe Sciabica, the new AFCEC Director and member of the Senior Executive Service. He was previously the Air Force Research Laboratory Executive Director and had no Civil Engineer background. His relevant experience in merging diverse organizations in previous assignments played a major role in his selection. He also brought a fresh outlook to the organization that proved valuable in smoothing the transition. AFCEC had two deputies, one in San Antonio and one at Tyndall. Brig. Gen. Vincent M. Saroni, the Mobilization Assistant to The Air Force Civil Engineer became the initial deputy at San Antonio. As the head of the AFCEC Transition Team, General Saroni had been intimately involved in the merger preparations. Col. David L. Reynolds, the AFCESA Commander, became the AFCEC-Tyndall Deputy Director. Mr. Robert M. Moore, AFRPA's last Director, became the AFCEC Installations Director. (Sadly, Mr. Moore passed away suddenly on June 3, 2013.) Mr. Terry G. Edwards, AFCEE's last director, became the Director of Communications, Installations and Mission Support, HQ Air Force Materiel Command in 2012. Both Mr. Moore and Mr. Edwards were members of the Senior Executive Service.[4]

AFCEC was organized into seven directorates: Energy; Environmental; Facility Engineering; Installations; Operations; Planning and Integration; and Readiness. The FOA also included a Chief Financial Officer, Chief Information Office, Staff Judge Advocate, Director of Staff, and an office that was part of the Air Force Deputy General Counsel (Installations, Energy, and Environment Division).

Because AFCESA and AFCEE both reported to the Office of The Civil Engineer, an Air Staff office, and AFRPA was under the Assistant Secretary of the Air Force for Installations, Environment and Logistics, the lines of authority and delegations of authorities for the new FOA had to be ironed out before the merger. After much discussion, the existing Secretariat delegations of authority remained in place. PAD 12-03 established a direct line of authority between the AFCEC Installations Directorate and the Secretariat concerning real property and Base Relocation and Closure real property transactions. The PAD also included the requirement to keep the AFCEC Director and the Air Staff informed on pertinent issues.[5]

Figure 7.1 AFCEC Organizational Chart, 2012



AFCEC represented an important change in the nature of its predecessor FOAs, becoming an execution agency and not one serving solely as a customer response center. PAD 12-03 centralized several Environmental and Real Property functions at AFCEC. Building on the successful centralization of military construction execution and Environmental Restoration Account activities at AFCEE through PAD 07-02, the Air Force continued to consolidate additional activities at AFCEC, specifically MAJCOM Environmental Quality programs and National Environmental Policy Act (NEPA) Environmental Planning Function management and responsibilities. AFCEC's Environmental Directorate fully assumed MAJCOM responsibilities on October 1, 2012, while squadrons retained compliance responsibilities. A NEPA Center of Excellence, established at AFCEC to support Air Force Environmental Impact Analysis Process program management, included positions transferred from the MAJCOMs. Transitioning environmental programs to AFCEC required the use of Installation Support Teams as a temporary bridging strategy until full consolidation at AFCEC could be achieved. Centralization was expected to streamline program processes and improve information flow between the installations and AFCEC while increasing accountability, standardization, and transparency for the environmental program. AFCEC's Installation Directorate centralized all real estate responsibilities from the MAJCOMs. This included real estate transactions, real property accountability, execution of value-based transactions and post-closing management related to long-term leases, housing privatization and utilities privatization.[6]

One of AFCEC's most transformational elements was the Planning and Integration Directorate, which supported the Air Force and other services through the development of comprehensive investment strategies. Its purpose was to centralize, standardize, prioritize, and optimize the delivery of installation support by advocating and allocating resources to reduce the risk to the Air Force mission and Airmen. It provided strategic comprehensive planning, analyzed enterprise-wide common output level standards, and developed the Integrated Priority List, Air Force Activity Management Plan (AFAMP), and Air Force Comprehensive Asset Management Plan. The Planning and Integration Directorate include all AFAMP managers (Real Estate, Facilities, Utilities, Airfield and Transportation Networks, and Natural Infrastructure). The directorate centralized planning and integration strategy development to enable Air Force-wide portfolio management for the first time by combining mission risk, real-time facility condition assessment, and financial impacts to produce a single priority list for Air Force investment.[7]

As part of CET-A, MAJCOMs and installation-level units changed their organizational structure to consolidate, standardize, streamline, and enhance efficiency. Under Spiral 3, major command Environmental Quality, National Environmental Policy Act compliance, and real property management programs and processes were centralized at AFCEC. It also reorganized MAJCOM Civil Engineer staffs, which typically contained six divisions: Asset Management; Programs; Resources; Readiness; Operations; and Expeditionary Combat Support. The new structure reduced the number of divisions to five, realigning Asset Management, Programs, and Resources divisions into two new divisions: Engineering and Installation Management. Brig. Gen. Dave C. Howe, Director of Installations and Mission Support at Air Combat Command and the lead for designing the MAJCOM of the Future, said the MAJCOM Civil Engineer staff remained, “the primary interface between the bases, Headquarters Air Force and the Field Operating Agency and will continue advocating for facility and infrastructure needs while supporting Combatant Commanders, Numbered Air Forces and our installations.”[8]

Changes were also made at the installation level under Spiral 4. In 2007, PAD 07-02 restructured the squadrons, enhanced the EOD capabilities, and adopted a new Fire Emergency Services concept of operations. Therefore, the EOD, Readiness, and Fire Emergency Services flights were not changed as part of CET-A. One complicating factor for General Byers and his CET-A planners was that decisions related to Resource Management Directive 703, which directed that civilian staffing return to fiscal year 2010 levels, were done under a separate nondisclosure agreement. The mandated reduction of 1600 civilian positions within Civil Engineering heavily influenced CET-A’s Spiral 4 base-level efficiency initiatives. PAD 12-03 continued the PAD 07-02 call for squadrons to become smaller, more dependent on centralized planning, and adopt asset management business activities. PAD 12-03 changed the existing standard squadron that included seven flights: Asset Management, Operations, Readiness and Emergency Management, Resources, Programs, EOD, and Fire Emergency Services. The post-2012 revised squadron had six flights: Engineering, Operations, Readiness and Emergency Management, EOD, Installation Management, and Fire Emergency Services. The previous Resources, Programs, and Asset Management flights were integrated into Engineering and Installation Management flights. The 12-03 organizational framework implemented a more mature asset management vision and ensured that Activity Management Plan responsibilities were consistently assigned at all levels of Civil Engineer organizations.

While a new era in Air Force Civil Engineer history began on October 1, 2012, everyone present that day knew that more changes were to come. Civil Engineer leaders would face tightening budgets and increased centralization. However, civil engineers have a long record of overcoming challenges. Building on the foundation created by the thousands of civil engineers who had gone before them, today’s civil engineers approach each new challenge with the same spirit, enthusiasm and professionalism shown by their predecessors and continue their unsurpassed support to the Air Force mission.

ACKNOWLEDGEMENTS

This book represents the vision and energy of Dr. Ronald B. Hartzer, AFCEC History Office, and has been years in the making. During his career, Dr. Hartzer has assembled a comprehensive archive of material related to Air Force Civil Engineering at the AFCEC History Office at Tyndall AFB, Florida. The authors extend their thanks to the following persons and entities.

AFCEC History Office: Over the past three decades, Dr. Hartzer and the History Office staff have prepared the ground work for this book. They have collected materials and compiled research notes. Dr. Ronald B. Hartzer and Mrs. Lois E. Walker conducted oral interviews of former Air Force Civil Engineers and other key personnel throughout the Air Force Civil Engineer organization. Nameless assistants prepared typescripts, scanned magazine and paper archives, assembled graphics, and organized files. Mrs. Lois E. Walker prepared topics lists and preliminary chapter outlines, as well as drafts of topics for Chapters 1 and 2. Ms. Teresa Hood provided access to back issues of the Air Force Civil Engineer magazine. All data were shared unstintingly with the research team of R. Christopher Goodwin & Associates (RCGA), Inc., who began in late 2008 to prepare the book manuscript. Dr. Hartzer guided the final selection of topics included in the book; provided countless hours of advice on the significance of particular issues; unfettered access to his files, often providing the key documents for each topic; ensured adequate coverage of the topics; prepared the front and back matter; drafted numerous sections of the manuscript; and carefully read and checked each draft chapter.

Research Repositories: Several research repositories were accessed during the preparation of this book: the Muir S. Fairchild Research Information Center, Air University, Maxwell Air Force Base, Alabama; the Air Force Historical Research Agency, Air University, Maxwell Air Force Base, Alabama; the Library of Congress, Washington, D.C.; and, the National Archives and Records Administration, College Park, Maryland. At each repository, the RCGA, Inc., research team was assisted greatly by the professional librarians and staff members who answered questions, provided guidance, and retrieved materials. In particular, we were assisted by Ms. Tammy Horton and Dr. Daniel Haulman at the Air Force Historical Research Agency at Maxwell AFB.

Air Force Civil Engineers: The authors wish to extend their thanks to all Air Force civil engineers, past and present, who wrote about their experiences in the *Air Force Civil Engineer* magazine, consented to being interviewed about their experiences, and saved and shared their documentation. This history reflects their stories and their pride in the work they do.

Mr. Jeff Pendleton, a graphic specialist at AFCEC, did the layout for the book and used his exceptional talents to improve the overall appearance.

Ms. Vicki Brown, a Northrop Grumman employee, did a thorough review of the entire manuscript and offered several improvements to the chapters.

Cheryl Hartzer spent many nights and weekends painstakingly reviewing chapters of the book multiple times and helped make it a much better product.

Civil Engineer Founders willingly volunteered their time to review all or part of the manuscript and offered numerous suggestions.

R. Christopher Goodwin & Associates, Inc.: The authors wish to thank R. Christopher Goodwin for his support throughout the preparation of this history, which was a long-term, multi-year effort.

APPENDIX A

CIVIL ENGINEER LEADERS

DIRECTORS/AIR FORCE CIVIL ENGINEERS

Brig Gen Robert Kauch	Director of Air Installations	Sep 1944-Jun 1948
Maj Gen Colby M. Myers	Director of Air Installations	Jun-Sep 1948
Maj Gen Grandison Gardner	Director of Air Installations	Sep 1948-Mar 1949
Maj Gen James B. Newman	Director of Installations	Mar 1949-May 1950
Maj Gen Colby M. Myers	Director of Installations	May-Dec 1950
Lt Gen Patrick W. Timberlake	Director of Installations	Dec 1950-Jan 1952
Maj Gen Colby M. Myers	Director of Installations	Jan-Jun 1952
Maj Gen Lee B. Washbourne	Asst Chief of Staff, Installations	Jun 1952-Mar 1957
Maj Gen Augustus M. Minton	Director of Installations	Jul 1957-Mar 1959
	Director of Civil Engineering	Mar 1959-Jul 1963
Maj Gen Robert H. Curtin	Director of Civil Engineering	Jul 1963-May 1968
Maj Gen Guy H. Goddard	Director of Civil Engineering	May 1968-Dec 1971
Maj Gen Maurice R. Reilly	Director of Civil Engineering	Jan 1972-Mar 1974
Maj Gen Billie J. McGarvey	Director of Civil Engineering	Mar 1974-Apr 1975
Maj Gen Robert C. Thompson	Director of Engineering & Svs	Apr 1975-Jun 1978
Maj Gen William D. Gilbert	Director of Engineering & Svs	Jul 1978-Aug 1982
Maj Gen Clifton D. Wright, Jr.	Director of Engineering & Svs	Aug 1982-Feb 1986
Maj Gen George E. Ellis	Director of Engineering & Svs	Mar 1986-Feb 1989
Maj Gen Joseph A. Ahearn	Director of Engineering & Svs	1 Mar 1989-31 Jan 1991
	The Air Force Civil Engineer	1 Feb 1991-31 Jan 1992
Mr. Gary S. Flora	The Air Force Civil Engineer	1 Feb 1992-27 Oct 1992
Maj Gen James E. McCarthy	The Air Force Civil Engineer	28 Oct 1992-21 Jul 1995
Maj Gen Eugene A. Lupia	The Air Force Civil Engineer	22 Jul 1995-23 Jul 1999
Maj Gen Earnest O. Robbins II	The Air Force Civil Engineer	23 Jul 1999-16 May 2003
Maj Gen L. Dean Fox	The Air Force Civil Engineer	16 May 2003-23 Jun 2006
Maj Gen Delwyn R. Eulberg	The Air Force Civil Engineer	23 Jun 2006-5 Jun 2010
Maj Gen Timothy A. Byers	The Air Force Civil Engineer	5 Jun 2010-22 Jun 2013
Maj Gen Theresa C. Carter	The Air Force Civil Engineer	22 Jun 2013-10 Mar 2014
Brig Gen Timothy S. Green	Director of Civil Engineers	31 Mar 2014-Present

ASSOCIATE/DEPUTY AIR FORCE CIVIL ENGINEERS

Mr. John R. Gibbens	Associate Dep Director for Construction	1963-1969
Mr. Rufus (Davy) L. Crockett	Associate Director, Civil Engineering	1969-1972
Mr. Harry P. Rietman	Associate Director, Engineering & Svs	1973-1985
Mr. Gary S. Flora	Associate Director, Engineering & Svs	1985-1991
	Associate Civil Engineer	1991-1994
Dr. Robert D. Wolff,	Associate Civil Engineer	1994-1997
Mr. Michael A. Aimone	Dep Air Force Civil Engineer	Jan 1999-Mar 2002
Ms. Kathleen I. Ferguson	Dep Air Force Civil Engineer	Apr 2002-Oct 2007
Mr. Paul Parker	Dep Air Force Civil Engineer	Nov 2007-Jul 2010
Mr. Mark A. Correll	Dep Air Force Civil Engineer	Nov 2010-Jun 2014

CIVIL ENGINEER CHIEFS OF ENLISTED MATTERS

CMSgt Larry R. Daniels	Chief, Enlisted Matters	Sep 1989-Jun 1992
CMSgt Larry R. Ward	Chief, Enlisted Matters	Mar 1994-Jul 1995
CMSgt Kenneth E. Miller	Chief, Enlisted Matters	Aug 1995-Jul 1998
CMSgt Richard D. Park	Chief, Enlisted Matters	Aug 1998-Jun 2000
CMSgt Michael F. Doris	Chief, Enlisted Matters	Jun 2000-Jun 2005
CMSgt Wayne E. Quattrone II	Chief, Enlisted Matters	Jun 2005-Feb 2008
CMSgt Patrick D. Abbott	Chief, Enlisted Matters	Feb 2008-Aug 2011
CMSgt Jerry W. Lewis	Chief, Enlisted Matters	Aug 2011-Present

APPENDIX B

OUTSTANDING CIVIL ENGINEER UNITS

(MAJ. GEN. ROBERT H. CURTIN AWARD)

YEAR	CATEGORY	UNIT	BASE
1966		4510th CES	Luke AFB, AZ
1967		96th CES	Dyess AFB, TX
1968		355th CES	Takhli Royal Thai AB
1969		4756th CES	Tyndall AFB, FL
1970		27th CES	Cannon AFB, NM
1971		3202d CES	Eglin AFB, FL
1972		Civil Engineering School	Wright-Patterson AFB, OH
1973		317th CES	Pope AFB, NC
1974		90th CES	F. E. Warren AFB, WYO
1975		67th CES	Bergstrom AFB, TX
1976		341st CES	Malmstrom AFB, MT
1977		475th CES	Yokota AFB, Japan
1978		52d CES	Spangdahlem AB, W. Germany
1979		100th CES	Beale AFB, CA
1980		56th CES	MacDill AFB, FL
1981		436th CES	Dover AFB, DE
1982		42d CES	Loring AFB, ME
1983		2849th CES	Hill AFB, UT
1984		432d CES	Misawa AB, Japan
1985		18th CEG	Kadena AB, Japan
1986		6510th CES	Edwards AFB, CA
1987	Large	325th CES	Tyndall AFB FL
1987	Small	347th CES	Moody AFB, GA
1988	Large	36th CES	Bitburg AB, W. Germany
1988	Small	1010th CES	Cheyenne Mt. Com., CO
1989	Large	2852d CES	McClellan AFB, CA
1989	Small	27th CES	Cannon AFB, NM
1990	Large	90th CES	F. E. Warren AFB, WY
1990	Small	5099th CE Ops Sq	Elmendorf AFB, AK
1991	Large	351st CES	Whiteman AFB, MO
1991	Small	27th CES	Cannon AFB, NM
1992	Large	355th CES	Davis-Monthan AFB, AZ
1992	Small	96th CES	Dyess AFB, TX
1993	Large	432d CES	Misawa AB, Japan

1993	Small	17th CES	Goodfellow AFB, TX
1994	Large	20th CES	Shaw AFB, S.C.
1994	Small	14th CES	Columbus AFB, MS
1995	Large	12th CES	Randolph AFB, TX
1995	Small	437th CES	Charleston AFB, SC
1996	Large	10th CEG	US Air Force Academy, CO
1996	Small	31st CES	Aviano, Italy
1997	Large	52d CES	Spangdahlem AB, GE
1997	Small	4th CES	Seymour Johnson AFB, NC
1998	Large	86th CES	Ramstein AB, GE
1998	Small	92nd CES	Fairchild AFB, WA
1999	Large	49th CES	Holloman AFB NM
1999	Small	56th CES	Luke AFB AZ
2000	Large	52d CES	Spangdahlem AB, Germany
2000	Small	92d CES	Fairchild AFB, WA
2001	Large	437th CES	Charleston AFB, SC
2001	Small	31st CES	Aviano AB, Italy
2002	Large	86th CEG	Ramstein AB, Germany
2002	Small	43d CES	Pope AFB, NC
2003	Large	52d CES	Spangdahlem AB, GE
2003	Small	27th CES	Cannon AFB, NM
2003	ARC	114th CES	Sioux Falls, SD
2004	Large	18th CEG	Kadena AB, Japan
2004	Small	341st CES	Malmstrom AFB, MT
2004	ARC	934th MSG/CE	Minneapolis-St. Paul IAP-ARS, MN
2005	Large	35th CES	Misawa AB, Japan
2005	Small	314th CES	Little Rock AFB, AR
2005	ARC	94th MSG/CE	Dobbins ARB, GA
2006	Large	3d CES	Elmendorf AFB, AK
2006	Small	100th CES	RAF Mildenhall, UK
2006	ARC	118th CES	Nashville, TN
2007	Large	4th CES	Seymour Johnson AFB, NC
2007	Small	21st CES	Peterson AFB, CO
2007	ARC	126th CES	Scott AFB, IL
2008	Large	18th CEG	Kadena AB, JAPAN
2008	Small	100th CES	RAF Mildenhall, UK
2008	ARC	108th CES	McGuire AFB NJ
2009	Large	60th CES	Travis AFB, CA
2009	Small	554th RED HORSE SQ	Andersen AB, Guam
2009	ARC	134th CES	McGhee Tyson ANGB, TN

2010	Large	4th CES	Seymour Johnson AFB, NC
2010	Small	23d CES	Moody AFB, GA
2010	ARC	482d CES	Homestead ARB, FL
2011	Large	52d CES	Spangdahlem AB, GE
2011	Small	355th CES	Davis-Monthan AFB, AZ
2011	ARC	115th CES	DCRA-Truax ANG Base, WI
2012	Large	49th CES	Holloman AFB, NM
2012	Small	27th SOCES	Cannon AFB, NM
2012	ARC	145th CES	Charlotte Douglas ANGB NC
2013	Large	87th CES	JB McGuire-Dix-Lakehurst, NJ
2013	Small	355th CES	Davis-Monthan AFB, AZ
2013	ARC	439th CES	Westover ARB, MA

ACRONYMS

AAA	Ascension Auxiliary Airfield
AAC	Alaskan Air Command
AAFES	Army and Air Forces Exchange Services
AARO	Assault, Assessment, and Repair Operations
AAS	Antigua Air Station
AB	Air Base
ABE	Alternative Base Energy
ABET	Accreditation Board of Engineering and Technology
ABO	airbase operability
AC&W	Aircraft Control and Warning
ACC	Air Combat Command
ACE	Aerospace Combat Engineer Force
ACES	Automated Civil Engineer System
ACRFAET	Aircraft Rescue Field Assistance and Evaluation Team
ADC	Air Defense Command
ADCON	administrative control
ADR	airfield damage repair
ADVON	advance echelon
AEDC	Arnold Engineering Development Center
AEF	Aerospace Expeditionary Forces
AEF	American Expeditionary Forces
AEF	Aviation Engineer Force
AETC	Air Education and Training Command
AEW	Expeditionary Wing
AFACA	Air Force Academy Construction Agency
AFB	Air Force Base
AFBDA	Air Force Base Disposal Agency
AFBMD	Air Force Ballistic Missile Division
AFCAP	Air Force Contract Augmentation Program
AFCEC	Air Force Civil Engineering Center
	Air Force Civil Engineer Center
AFCEE	Air Force Center for Environmental Excellence, changed to Air Force Center for Engineering and the Environment in 2007
AFCEMET	Air Force Civil Engineering Management Engineering Team
AFCESA	Air Force Civil Engineer Support Agency
AFDD	Air Force Doctrine Document
AFEM	Air Force Emergency Management
AF-EMIS	Air Force-Environmental Information Management System
AFESA	Air Force Engineering and Services Agency
AFESC	Air Force Engineering and Services Center
AFETO	Air Force Engineering Technology Office
AFFEC	Air Force Facility Energy Center
AFFF	Aqueous Film-Forming Foam
AFI	Air Force Instruction
AFIR	Air Force Installations Representatives
AFIT	Air Force Institute of Technology
AFLC	Air Force Logistics Command
AFM	Air Force Manual

AFMC	Air Force Materiel Command
AFMEA	Air Force Management Engineering Agency
AFMPC	Air Force Military Personnel Center
AFR	Air Force Regulation
AFRCE	Air Force Regional Civil Engineer
AFRCE-CR	Air Force Regional Civil Engineer-Central Region
AFRES	Air Force Reserves
AFRL	Air Force Research Laboratory
AFRPA	Air Force Real Property Agency
AFSC	Air Force Specialty Code
AFSC	Air Force Systems Command
AFSO21	Air Force Smart Operations 21
AFSOC	Air Force Special Operations Command
AFSOS	Automated Food Service Operations System
AFSPC	Air Force Space Command
AFWL	Air Force Weapons Laboratory
AICUZ	Air Installation Compatible Use Zone
AIM	Agile Installation Management
AIO	Air installation officer
ALC	A La Carte
ALCM	Air-Launched Cruise Missile
AM-2	Aluminum Matting
AMC	Air Materiel Command
AMC	Air Mobility Command
AMP	Activity Management Plan
ANFA	Aniline Furfuryl Alcohol
ANG	Air National Guard
AOR	area of responsibility
APE	Airfield Pavement Evaluation
ARDC	Air Research and Development Command
ARF	Air Reserve Forces
ARRK	Air Rapid Response Kit
ASCE	American Society of Civil Engineers
ASD	Aeronautical Systems Division
ASTF	Aeropropulsion Systems Test Facility
ATC	Air Training Command
AWACS	Airborne Warning and Control System
BAK	Barrier Arresting Kit
BALANCE	Basic and Logically Applied Norms-Civil Engineering
BASH	Bird/Aircraft Strike Hazard
BCAMPs	base comprehensive AMPs
BCE	base civil engineer
BDP	base development plans
BDR	bomb damage repair
BEAMS	Base Engineer Automated Management System
BEAR	Basic Expeditionary Airfield Resources
BEET	Base Engineer Emergency Team Concept
BIAP	Baghdad International Airport
BMAG	Base Management Action Group

BMAR	Backlog of Maintenance and Repair
BMD	Ballistic Missile Division
BMEWS	Ballistic Missile Early Warning System
BMO	Ballistic Missile Office
BMS	Ballistic Missile Support
BOS	Base Operating Support
BRAAT	base recovery after attack
BRAC	Base Realignment and Closure
BSD	Ballistic Systems Division
BSR	blue suit review
CAA	Civil Aeronautics Authority
CADD	Computer Aided Design and Drafting
CAOC	Combined Air Operations Center
CAP	combat air patrol
CAT	Civic Action Teams
CCC	Civilian Conservation Corps
CCD	camouflage, concealment, and deception
CCMAS	Construction Cost Management Analysis System
CEC	Civil Engineer Council
CEC	Civil Engineering Center
CECOG	Civil Engineer Construction Operations Group
CECORS	Civil Engineer Contract Reporting System
CEEDO	Civil and Environmental Engineering Development Office
CEF	Civil Engineering Flight
CEFAC	Civil Engineering Field Activities Center
CEG	Civil Engineer Group
CEMAS	Civil Engineering Materiel Acquisition System
CEMAT	Civil Engineer Management Team
CEMET	Civil Engineering Management Evaluation Team
CEMIRT	Civil Engineering Maintenance, Inspection, Repair, and Training. The name was changed in 1991 to become Civil Engineering Maintenance, Inspection, and Repair Team
CES	Civil Engineering Squadron
CES (HR)	Civil Engineering Squadron (Heavy Repair)
CESMET	Civil Engineering and Services Management Evaluation Team
CESS	Civil Engineer and Services School
CET-A	Civil Engineer Transformation—Accelerated
CETSO	Civil Engineer Technical Support Office
CFETPs	Career Field Education and Training Plans
CIF	Consolidated Instrumentation Facility
CINC	Commander-in-Chief
CINCPAC	Commander-in-Chief, Pacific
CIP	Common Installation Picture
CJTF-HOA	Combined Joint Task Force-HORN OF AFRICA
CLP	Combat Logistics Patrol
CMSAF	Chief Master Sergeant of the Air Force
CMSgt	Chief Master Sergeant
CNR	Composite Noise Rating
COB	Colocated Operating Bases

CoBRA	Combat Battlefield Ready Airman
COCESS	Contractor Operated Civil Engineer Supply Store
COCOM	Combatant Commander
ConAC	Continental Air Command
CONOPs	concept of operations
CONUS	Continental United States
CoPs	Communities of Practice
CORE	Combat Oriented Results Engineering
COTS	commercial-off-the-shelf
CPA	Coalition Provisional Authority
CPM	Critical Path Method
CPU	central processing unit
CRATR	Critical Runway Assessment and Repair
CREATE	Computational Resources for Engineering and Simulation, Training and Education
CRTC	Combat Readiness Training Center
CSG	Combat support group
CSOC	Consolidated Space Operations Center
CSU	Civilian Service Unit
CTC	Closing the Circle
CTF	Combined Task Force
CTS	Construction and Training Squadron
CUD	Compatible Use Districts
DCS/PR	Deputy Chief of Staff/Programs and Resources
DEW	Distant Early Warning
dL	distributed learning
DMRD	Defense Management Report Decision
DoD	Department of Defense
DP	Disaster Preparedness
DPRS	deployable pavement repair system
DRID	Defense Reform Initiative Directive
EA	environmental assessments
EAEC	European Aviation Engineer Command
EAF	Expeditionary Aerospace Force
EAG	Engineer Aviation Group
ECES	Expeditionary Civil Engineer Squadron
ECIP	Energy Conservation Investment Program
ECOS	Environmental, Construction and Operations & Services
EIS	environmental impact statement
EMSG	Expeditionary Mission Support Group
ENCAP	Engineering civil assistance program
ENCOM	Engineer Construction Command
ENVEST	Environmental Estimating
EO	Executive Order
EOD	Explosives Ordnance Disposal
EPA	Environmental Protection Agency
EPBG	Expeditionary Prime BEEF Group
EPBS	Expeditionary Prime BEEF Squadron
ERDA	Energy Research and Development Agency

ERHS	Expeditionary RED HORSE Squadron
ESCCMP	Engineering and Services Civilian Career Management Program
ESD	Electronic Systems Division
ESIMS	Engineering and Services Information Management System
ESL	Engineering and Services Laboratory
ESPC	Energy Savings Performance Contract
EUL	enhanced use lease
EWI	Education-With-Industry
EXP	Expandable Shelter
FEAF	Far East Air Forces
FEMA	Federal Emergency Management Agency
FERL	Field Engineering and Readiness Laboratory
FHA	Federal Housing Administration
FMS	foreign military sales
FOA	field operating agency
FOB	Forward operating base
FP	Force Protection
FRELOC	Operation FAST RELOCATION
FSTR	Full Spectrum Threat Response
FWPCA	Federal Water Pollution Control Act
GAO	General Accounting Office
GEEM	Graduate Engineering and Environmental Management
GEM	Graduate Engineering Management
GES	Graduate Education Subcommittee
GIS	Geographical Information System
GLCMs	Ground-Launched Cruise Missiles
GMAT	Graduate Management Aptitude Test
GPA	grade point average
GPS	Global Positioning System
GRE	Graduate Records Examination
GRS	Gulf Region South
GSA	General Services Administration
GWOT	Global War on Terrorism, renamed Overseas Contingency Operations (OCO)
HAF GIO	Headquarters Air Force Geo Integration Office
HAZMAT	hazardous materials
HERC	Heavy Engineering Repair and Construction
HSSB	Humanitarian Service Support Base
HUD	U.S. Department of Housing and Urban Development
HVAC	heating, air conditioning, and refrigeration
IA	individual augmentation
IBM	International Business Machines
ICAF	Industrial College of the Armed Forces
ICBM	intercontinental ballistic missile
ID/IQ	Indefinite delivery/indefinite quantity
IED	improvised explosive device
ILO	in lieu of
IMA	Individual Mobilization Augmentees
IPT	Integrated process teams
IRBM	intermediate range ballistic missile

IRFNA	inhibited red fuming nitric acid
IRP	Installation Restoration Program
IRS	Information Requirements Study
IRT	Innovative Readiness Training
ITRO	Interservice Training Review Organization
IWIMS	Interim Work Information Management System
JCA	Joint Construction Agency
JEOC	Joint Engineer Operations Course
JET	Joint Expeditionary Taskings
JLUS	Joint Land Use Study
JOA	Joint Operations Area
JOEB	Joint Operational Engineering Board
JTF	Joint Task Force
KKMC	King Khalid Military City
KMCC	Kaiserslautern Military Community Center
LAN	local area networks
LEED	Leadership in Energy and Environmental Design
LRRS	Long Range Radar Station
LSU	Labor Service Unit
MAAS	mobile aircraft arresting systems
MAC	Military Airlift Command
MACV	Military Assistance Command, Vietnam
MAJCOM	major command
MAP	Management Action Plan
MATS	Military Air Transport Service
MCAMP	major command AMP
MCP	Military Construction Program
MCST	Mobile Combat Support Team
MEF	Minimum Essential Facilities
MET	Mission Essential Tasks
MFH	Military Family Housing
MILCON	Military Construction
MMS	Materiel Maintenance Squadron
MOOTW	military operations other than war
MOS	Military Occupational Specialty
MST	mobile service tower
MTO	Mediterranean Theater of Operations
MWR	Morale, Welfare, and Recreation
MWRS	Morale Welfare, Recreation and Services
MX	Missile-X
NACA	National Advisory Committee for Aeronautics
NAF	non-appropriated funding
NAS	Naval Air Station
NASA	National Aeronautics and Space Administration
NATO	North Atlantic Treaty Organization
NBC	Nuclear, Biological and Chemical
NCO	non-commissioned officer
NEF	Noise Exposure Forecast
NEPA	National Environmental Protection Act

NFPA	National Fire Protection Association
NHPA	National Historic Preservation Act of 1966
NORAD	North American Air Defense Command
NSC	National Security Council
NVG	night vision goggles
O&M	operations and maintenance
OAF	Occupation Air Forces
OAS	Organization of American States
OEF	Operation ENDURING FREEDOM
OER	Officer Evaluation Report
OFDA	Office of Foreign Disaster Assistance
OFE	officer field education
OICC	Officer in Charge of Construction
OIF	Operation IRAQI FREEDOM
OJT	on-the-job training
OMB	Office of Management and Budget
ONE	Operation NOBLE EAGLE
OPC	Operation PROVIDE COMFORT
OPCON	operational control
OPlan	Operations Plan
OPSCEAF	Operation Civil Engineering Air Force
OPSTEMPO	operations tempo
ORI	operational readiness inspection
OSD	Office of the Secretary of Defense
P2OA	Pollution Prevention Opportunity Assessment
PACAF	Pacific Air Forces
PAD	Program Action Directive
PBD	Program Budget Decision
PBR	Performance-Based Restoration
PCR	Payload Changeout Room
PCS	permanent change of station
PDC	Primary Distribution Center
PDC	Programming, Design and Construction
PE	Professional Engineer
PEACE	Program Evaluation and Assistance-Civil Engineering
PERT	Program Evaluation and Review Technique
PMO	program management office
POL	petroleum, oils, and lubricants
POM	Program Objective Memorandum
PPR	Payload Preparation Room
PRAM	Plastic Reclaimable Abrasive Machine
PRC	Program Review Committee
PRDC	Provincial Reconstruction Development Committee
Prime BEEF	Prime Base Engineer Emergency Force
PRT	Provincial Reconstruction Team
PSP	pierced steel planking
QDR	Quadrennial Defense Review
R&D	research and development
RAA	Resource Recovery Act

RACER	Remedial Action Cost Estimating and Requirements
RAF	Royal Air Force
RC	Readiness Challenge
RCA	Radio Corporation of America
RDJTF	Rapid Deployment Joint Task Force
RED HORSE	Rapid Engineer Deployable Heavy Operational Repair Squadron, Engineer
REOTS	Regional Equipment Operator Training Site
RFP	requests for proposal
RIBS	Prime Readiness in Base Services
RMK-BRJ	Raymond, Morrison-Brown and Root and A.J. Jones
RMS	Readiness Management Support, L.C.
ROOM	Readiness and Ownership Oriented Management
ROWPU	reverse osmosis water purification unit
RPIE	real property installed equipment
RPO	Remedial Process Optimization
RRR	rapid runway repair
RSAF	Royal Saudi Air Force
RTAFB	Royal Thai Air Force Base
RTS	Regional Training Site
S/R&M	Sustainment, restoration and modernization
SAB	Scientific Advisory Board
SAB	Shuttle Assembly Building
SABER	Simplified Acquisition of Base Engineering Requirements
SAC	Strategic Air Command
SAGE	Semi-automatic Ground Environment
SAME	Society of American Military Engineers
SAMSO	Space and Missile Systems Office
SARPMA	San Antonio Real Property Maintenance Agency
SATOC	S/R&M Acquisition Task Order Contract
SATS	Short Airfield for Tactical Support
SCADA	Supervisory Control and Data Acquisition
SCARWAF	Special Category Army Personnel with Air Force
SDC	Secondary Distribution Center
SETAF	Southern European Task Force
SFG	Security Forces Group
SGC	Space Guidance Center
SIMS	Services Information Management System
SMART	Structural Maintenance and Repair Teams
SO&M	Skidmore, Owings and Merrill
SOA	separate operating agency
SOF	Special Operations Forces
SON	Statement of Need
SORTS	Status of Resources and Training
SRB	solid rocket booster
SSD	Space Systems Division
S-Teams	Staff Augmentation Teams
STS	Specialty Training Standards
SVE	soil vapor extraction
SWA	Southwest Asia

TABVEE	Theater Air Base Vulnerability Estimate and Evaluation
TAC	Tactical Air Command
TACON	tactical control
TCPS	Transportable Collective Protection System
TEMPER	Tent Extendable Modular, Personnel
TFW	Tactical Fighter Wing
TKC	Turnkey Contract
TLF	temporary living facility
TLQ	Temporary Living Quarters
TO&E	Tables of Organization and Equipment
TRACES	Tri-Service Automated Cost Engineering System
TT	Texas Tower
U.S.S.R.	Union of Soviet Socialist Republics
UAE	United Arab Emirates
UN	United Nations
UPH	unaccompanied personnel housing
USAFA	U.S. Air Force Academy
USAFE	U.S. Air Forces in Europe
USAREUR	United States Army in Europe
USCENTAF	U.S. Air Forces Central Command
USCENTCOM	U.S. Central Command
USPACOM	U.S. Pacific Command
USSOUTHCOM	U.S. Southern Command
USSTAF	U.S. Strategic Air Forces
UTC	Unit Type Codes
UXO	unexploded ordnance
WADC	Wright Air Development Center
WAN	wide area networks
WDD	Western Development Division
WECO	Western Electric Company
WERC	Worldwide Environmental Restoration and Construction
WES	Waterways Experiment Station
WIMS	Work Information Management System
WMD	weapons of mass destruction
WRM	war readiness materials

Chapter 1 Endnotes

1 Alfred Goldberg, ed., *A History of the United States Air Force 1907-1957*, D. Van Nostrand Company, Inc., Princeton, New Jersey, 1957, reprint, Arno Press, Inc., New York, 1974, 3 (page citations are to the reprint edition); Alfred F. Hurley and William C. Heimdahl, "The Roots of U.S. Military Aviation," *Winged Shield, Winged Sword, A History of the United States Air Force,* Government Printing Office, 1997, Washington DC, 14; Dr. Ronald B, Hartzer "Foundations for the Future A History of Air Force Civil Engineers," 2005, Files of AFCEC History Office, Tyndall AFB, Florida [hereafter cited as AHO].

2 Lois E. Walker, and Shelby E. Wickam, *From Huffman Prairie to the Moon: The History of Wright-Patterson AFB,* Government Printing Office, Washington, D.C., 1986, 9, 17-18.

3 Ibid. 18-19.

4 Ibid. 18.

5 Henry H. Arnold, *Global Mission*, Harper, New York, 1949, 30; Juliette A. Hennessy, *The United States Army Air Arm, April 1861 to April 1917*, Office of Air Force History, Washington, D.C., 1985, 55-57, 61, 73; David R. Jones and Royden W. Marsh, *Flight Surgeon Support to United States Air Force Fliers in Combat,* United States Air Force School of Aerospace Medicine, Brooks City-Base, Texas, 2003, 2.

6 Juliette A. Hennessy, *The United States Army Air Arm, April 1861 to April 1917*, Office of Air Force History, Washington, D.C., 1985, 73.

7 Ibid. 76.

8 Juliette A. Hennessy, *The United States Army Air Arm, April 1861 to April 1917*, Office of Air Force History, Washington, D.C., 1985, 86, 91, 121-122, 136, 137; Jerold E. Brown, *Where Eagles Roost: A History of Army Airfields Before World War II*, PhD Dissertation for Department of History, Duke University, Durham, North Carolina, September 1977 [hereafter cited as Eagles Roost], 50.

9 Eagles Roost 50-51, 53; Jerold E. Brown, *Where Eagles Land, Planning and Development of U.S. Army Airfields, 1910-1941*, Greenwood Press, New York, New York, 1990, 2.

10 Juliette A. Hennessy, *The United States Army Air Arm, April 1861 to April 1917*, Office of Air Force History, Washington, D.C., 1985, 79-80, 84.

11 Ibid. 78, 132.

12 Ibid. 109-110.

13 Frederick J. Shaw, ed., *Locating Air Force Base Sites, History's Legacy,* Air Force History and Museum Program, Washington, D.C., 2004, [hereafter cited as Shaw]10.

14 Eagles Roost 48; Juliette A. Hennessy, *The United States Army Air Arm, April 1861 to April 1917*, Office of Air Force History, Washington, D.C., 1985, 160.

15 Roger G. Miller, *A Preliminary to War: The 1st Aero Squadron and the Mexican Punitive Expedition of 1916,* Air Force History and Museums Program, Washington, D.C., 2003; Eagles Roost 57.

16 Roger G. Miller, *A Preliminary to War: The 1st Aero Squadron and the Mexican Punitive Expedition of 1916,* Air Force History and Museums Program, Washington, D.C., 2003, 47.

17 Ibid; Maj. Gen. Benjamin D. Foulois with Col. C.V. Glines, USAF, *From the Wright Brothers to the Astronauts, The Memoirs of Major General Benjamin D. Foulois*, McGraw-Hill Book Company, New York, New York, 1968, 139-140.

18 Ibid.

19 Roger G. Miller, *A Preliminary to War: The 1st Aero Squadron and the Mexican Punitive Expedition of 1916,* Air Force History and Museums Program, Washington, D.C., 2003, 47.

20 Juliette A. Hennessy, *The United States Army Air Arm, April 1861 to April 1917*, Office of Air Force History, Washington, D.C., 1985, 165, 192.

21 Ibid., 1985, 154; Lois E. Walker, and Shelby E. Wickam, *From Huffman Prairie to the Moon: The History of Wright-Patterson AFB,* Government Printing Office, Washington, D.C., 1986, 20-21.

22 Juliette A. Hennessy, *The United States Army Air Arm, April 1861 to April 1917*, Office of Air Force History, Washington, D.C., 1985, 192.

23 Eagles Roost 58-59.

24 Eagles Roost 64-65; Lois E. Walker, and Shelby E. Wickam, *From Huffman Prairie to the Moon: The History of Wright-Patterson AFB,* Government Printing Office, Washington, D.C., 1986, 85-87.

25 Eagles Roost 77.

26 Ibid. 93, 103.

27 Ibid. 79-80.

28 Lenore Fine and Jesse A. Remington, *United States Army in World War II, The Technical Services, The Corps of Engineers: Construction in the United States,* Center of Military History, U.S. Army, Washington, D.C. 1989, 18-21.

29 Lt. Col. Thomas E. Greacen, II, "The Buildings and Grounds Office of the Army Air Corps, 1918-1944," AFHRA No 00117504, 29 March 1944, 5-6, AHO.

30 Eagles Roost 72.

31 Ibid. 22, 79-82.

32 Lois E. Walker, and Shelby E. Wickam, *From Huffman Prairie to the Moon: The History of Wright-Patterson AFB,* Government Printing Office, Washington, D.C., 1986, 21-22; Juliette A. Hennessy, *The United*

States Army Air Arm, April 1861 to April 1917, Office of Air Force History, Washington, D.C., 1985, 27-29.

33 Eagles Roost, p 89.

34 Lois E. Walker, and Shelby E. Wickam, *From Huffman Prairie to the Moon: The History of Wright-Patterson AFB,* Government Printing Office, Washington, D.C., 1986, 36.

35 Ibid. 36.

36 Ibid. 36, 44;

37 "Statistics," *The Military Engineer* [hereafter cited as TME], Vol 12, January-February 1920, 39.

38 Maj. E. Graves, "The Methods of Construction in War," *TME*, Vol 12, July-August 1920, 432.

39 Ibid. 432.

40 "History of the 462d Aero Squadron," Provided to AFCEC History Office by Lt. Col. James D. Martin (USAF Retired) through 7 September 2007 correspondence, Files of AFCESA History Office, Tyndall, AFB, Florida; "Air Force Historical Research Agency Fact Sheet," U.S. Air Force, accessed 4 October 2011, www.afhra.af.mil.

41 See note above.

42 See note above.

43 See note above.

44 See note above.

45 Maurer Maurer, ed. *The U.S. Air Service in World War I*, Vol IV, The Albert F. Simpson Historical Research Center Maxwell AFB, Alabama, 1978, 241-243.

46 H.A.Toulmin, Jr., "Air Corps, A.E.F., 1918," *TME*, Vol 23, September-October 1931, 413-432; "Colonel Mason M. Patrick, Corps of Engineers, Appointed Chief of the Army Air Service," *TME*, Vol 13, September-October 1921, 478.

47 Alfred Goldberg, ed., *A History of the United States Air Force 1907-1957*, D. Van Nostrand Company, Inc., Princeton, New Jersey, 1957, reprint, Arno Press, Inc., New York, 1974, 22-26 (page citations are to the reprint edition).

48 Lois E. Walker, and Shelby E.Wickam, *From Huffman Prairie to the Moon: The History of Wright-Patterson AFB,* Government Printing Office, Washington, D.C., 1986, 65.

49 Col. R. R. Ralston, "Engineer Duties in the Field of War," *TME*, Vol 13, January-February 1920, 21; Maj. Gen. Mason M. Patrick, "Report of Chief of Air Service, AEF," *TME*, July-August 1921, 364.

50 "Statistics," *TME*, Vol 12, January-February 1920, 39.

51 Alfred Goldberg, ed., *A History of the United States Air Force 1907-1957*, D. Van Nostrand Company, Inc., Princeton, New Jersey, 1957, reprint, Arno Press, Inc., New York, 1974, 29 (page citations are to the reprint edition); Lt. Col. Thomas E. Greacen, II, "The Buildings and Grounds Office of the Army Air Corps, 1918-1944," AFHRA No 00117504, 29 March 1944, 12, AHO.

52 Eagles Roost 110-111.

53 Lt. Col. Thomas E. Greacen, II, "The Buildings and Grounds Office of the Army Air Corps, 1918-1944," AFHRA No 00117504, 29 March 1944, 6-7, AHO.

54 Ibid., 9-10, AHO; Eagles Roost 17-18.

55 Lt. Col. Thomas E. Greacen, II, "The Buildings and Grounds Office of the Army Air Corps, 1918-1944," AFHRA No 00117504, 29 March 1944, 6-8, AHO.

56 Manufacturers Aircraft Association, Inc., *Aircraft Year Book*, Doubleday, Page and Company for the Manufacturers Aircraft Association, Inc., New York, New York 1920, 298.

57 Lois E. Walker, and Shelby E. Wickam, *From Huffman Prairie to the Moon: The History of Wright-Patterson AFB,* Government Printing Office, Washington, D.C., 1986, 78.

58 Ibid.; Maurer Maurer, *Aviation in the U.S. Army 1919-1939,* Office of Air Force History, Washington, D.C., 1987, 150-152.

59 Eagles Roost 147-148.

60 Alfred Goldberg, ed., *A History of the United States Air Force 1907-1957*, D. Van Nostrand Company, Inc., Princeton, New Jersey, 1957, reprint, Arno Press, Inc., New York, 1974, 36 (page citations are to the reprint edition).

61 Lt. Col. Thomas E. Greacen, II, "The Buildings and Grounds Office of the Army Air Corps, 1918-1944," AFHRA No 00117504, 29 March 1944, 14, AHO.

62 Alfred Goldberg, ed., *A History of the United States Air Force 1907-1957*, D. Van Nostrand Company, Inc., Princeton, New Jersey, 1957, reprint, Arno Press, Inc., New York, 1974, 36-37 (page citations are to the reprint edition); Eagles Roost 54-55.

63 Eagles Roost 54-55.

64 George B. Ford, "New Army Posts for Old," *The Quartermaster Review*, Vol 9, November-December, 1929, 19-22; Howard Nurse, "The Planning of Army Posts," *The Quartermaster Review*, Vol. 8, September-October, 1928, 14-16; Francis B. Wheaton, "The Architecture of the Army Post," *The Quartermaster Review,* Vol 8, September-October 1928, 10-13; Francis B. Wheaton, "Housing the Army," *The Quartermaster Review*, Vol 11, March-April 1931, 11-18.

65 George Lamb, "Some Interesting Facts About Barksdale Field" *Service News,* Vol 1 No 1, December 1932.

66 Thomas Manning, "The Origins of Randolph AFB" 1987, n.p., MSS, Air Training Command History

Office, Randolph Air Force Base, Texas.

67 Maj. E.G. Thomas, "Housing for the Army," *The Quartermaster Review*, Vol 20, May-June, 1940, 27-29, 62-64.

68 Lt. Col. Thomas E. Greacen, II, "The Buildings and Grounds Office of the Army Air Corps, 1918-1944," AFHRA No 00117504, 29 March 1944, 14-15, AHO.

69 Goldberg, *A History of the USAF 1907-1957*, p 37; Victoria Clow, *et al*., *The Architecture of Randolph Field, 1928-1931*, Plano, Texas: Geo-Marine, Inc., 1998.

70 Lt. Col. Thomas E. Greacen, II, "The Buildings and Grounds Office of the Army Air Corps, 1918-1944," AFHRA No 00117504, 29 March 1944, 17-18, AHO; Historic American Buildings Survey/Historic American Engineering Records [hereafter cited as HABS/HAER], *The Engineering of Flight: Aeronautical Engineering Facilities of Area B, Wright-Patterson AFB, Ohio,* Washington, D.C., National Park Service, 1993, pp xvi-xvii; Walker and Wickam, *Huffman Prairie to the Moon*, p 79.

71 Shaw, *Locating Air Force Base Sites*, p 18.

72 HABS/HAER, *The Engineering of Flight*, p 11.

73 Lt. Col. Thomas E. Greacen, II, "The Buildings and Grounds Office of the Army Air Corps, 1918-1944," AFHRA No 00117504, 29 March 1944, 15-17, AHO; Eagles Roost 184.

74 Lt. Col. Thomas E. Greacen, II, "The Buildings and Grounds Office of the Army Air Corps, 1918-1944," AFHRA No 00117504, 29 March 1944, 19, AHO; Eagles Roost 177-182.

75 Eagles Roost 185-186.

76 Eagles Roost 188; Shaw, 18-19.

77 Brown, *Where Eagles Roost*, pp 189-191, 239, 249.

78 Walker and Wickam, *Huffman Prairie to the Moon,* pp 142, 264; Guthrie, Maj John D., "The Civilian Conservation Corps," *TME*, Jan-Feb 1934, pp 15-19.

79 Office of Construction Branch, Army Quartermaster Corps, "Army Construction," *Quartermaster Review*, Jul-Aug 1937.

80 Lt. Col. Thomas E. Greacen, II, "The Buildings and Grounds Office of the Army Air Corps, 1918-1944," AFHRA No 00117504, 29 March 1944, pp 20-23.

81 Office of Construction Branch, Army Quartermaster Corps, "Army Construction," *Quartermaster Review*, Jul-Aug 1937.

82 Shaw, 19; Alfred Goldberg, ed., *A History of the United States Air Force 1907-1957*, D. Van Nostrand Company, Inc., Princeton, New Jersey, 1957, reprint, Arno Press, Inc., New York, 1974, 39-40 (page citations are to the reprint edition).

83 Eagles Roost 208-09; Shaw, 19.

84 Lt. Col. Thomas E. Greacen, II, "The Buildings and Grounds Office of the Army Air Corps, 1918-1944," AFHRA No 00117504, 29 March 1944, 23-24, AHO.

85 Office of Construction Branch, Army Quartermaster Corps, "Army Construction," *Quartermaster Review*, Jul-Aug 1937.

86 Ibid.

87 Shaw, 20-22; Eagles Roost 218, 231.

88 Maj. John A. Hunt, "Construction of Hickam Field," *Quartermaster Review*, Nov-Dec 1940, 41-43, 77-78.

89 Shaw, 21; "Sustineo Alas (I Sustain the Wings): The History of Lowry Air Force Base," AHO.

90 Douglas E. Courchene, *Pioneers with Intent: Memoirs of an Air Force Fire Fighter*, Air Force Civil Engineer Support Agency, Tyndall AFB, Florida, July 2003, 3.

91 Eagles Roost 3.

92 Alfred Goldberg, ed., *A History of the United States Air Force 1907-1957*, D. Van Nostrand Company, Inc., Princeton, New Jersey, 1957, reprint, Arno Press, Inc., New York, 1974, 47-48 (page citations are to the reprint edition).

93 Eagles Roost 287; George R. Goethals, "The Present Status of Airport Engineering," *TME*, Vol 23, May-June 1931.

94 Eagles Roost 249-253; 275-76, 287; Dr. Charles Hendricks, "Building the Atlantic Bases: The Northern Route," *TME*, Vol 84, January-February 1992; Dr. Charles Hendricks, "Building the Atlantic Bases: The Southern Route," *TME*, Vol 84, March-April 1992.

95 Shaw, 28-29.

96 Alfred Goldberg, ed., *A History of the United States Air Force 1907-1957*, D. Van Nostrand Company, Inc., Princeton, New Jersey, 1957, reprint, Arno Press, Inc., New York, 1974, 50 (page citations are to the reprint edition).

97 Ibid.; Bernard C. Nalty, ed., *Winged Shield, Winged Sword: A History of the United States Air Force,* Vol I, Air Force History and Museums Program, Washington, D.C., 1997, 157.

98 Alfred Goldberg, ed., *A History of the United States Air Force 1907-1957*, D. Van Nostrand Company, Inc., Princeton, New Jersey, 1957, reprint, Arno Press, Inc., New York, 1974, 50-51 (page citations are to the reprint edition); Eagles Roost, 271-72.

99 Eagles Roost, 271-72.

100 Ibid, 269-70; "Tuskegee Airmen Civilian Pilot Training," National Park Service, accessed December

2011, www.cr.nps.gov/museum/exhibits/tuskegee/airtrain.htm.

101 "Tuskegee Airmen Civilian Pilot Training," National Park Service, accessed December 2011, www.cr.nps.gov/museum/exhibits/tuskegee/airtrain.htm.

102 Eagles Roost, 278-279.

103 Lt. Col. Thomas E. Greacen, II, "The Buildings and Grounds Office of the Army Air Corps, 1918-1944," AFHRA No 00117504, 29 March 1944, 31-34, AHO; Arlie C. Huffman, "Development of the Air Force Civil Engineering Function, 1918—Present," Directorate of Civil Engineering, May 1962; U.S. Air Force Biographies: Brigadier General Robert Kauch, U.S. Air Force, accessed various dates, www.af.mil/information/bios.

104 Lt. Col. Thomas E. Greacen, II, "The Buildings and Grounds Office of the Army Air Corps, 1918-1944," AFHRA No 00117504, 29 March 1944, 36, AHO; Shaw, 41; "Highway Landing Strips Proposed Directive," *Aviation Engineer Notes [hereafter cited as AEN]*, No 8, August 1942.

105 Wesley Frank Craven, and James Lea Cate, eds., *The Army Air Forces in World War II*, [hereafter cited as Craven and Cate]Vol 6: *Men and Planes*, 120.

106 Bernard C. Nalty, ed., *Winged Shield, Winged Sword: A History of the United States Air Force,* Vol I, Air Force History and Museums Program, Washington, D.C., 1997, 176-77.

Shaw, 41.

107 Dr. Ronald B. Hartzer, "Civil Engineering's Golden Legacy: A History of Air Force Civil Engineers," *Air Force Civil Engineer*, Vol 5, No 2, Summer 1997, 14; Shaw, 41-42; Wesley Frank Craven, and James Lea Cate, eds., *The Army Air Forces in World War II*, Vol 6: *Men and Planes*, 165-166.

108 William C. Baldwin, "Engineers in the Southwest Pacific, 1941-1944," *TME*, Vol 85, Mar-Apr 1993, 76; Dr. Ronald B. Hartzer, "Black Aviation Engineer Units of World War II," *Air Force Civil Engineer*, Vol 5, No 4, Winter 1998, 20; Craven and Cate, Vol 1: *Plans & Early Operations, January 1939 to August 1942*, 239; AF Pamphlet 10-219, Vol 1, *Contingency and Disaster Planning*, 1 December 1995, 8; "Story of the Airborne Aviation Engineers," *AEN*, No 12, February-March 1943.

109 Col. Stuart C. Godfrey, "Engineers with the Army Air Forces," *TME*, Vol 33, November 1941; AF Pamphlet 10-219, Vol 1, *Contingency and Disaster Planning*, 1 December 1995, 8; Lt. Robert S. McConnaughey, "Salvage at Eglin Field," *Quartermaster Review*, July-August 1944, 55-56.

110 Col. Stuart C. Godfrey, "Engineers with the Army Air Forces," *TME*, Vol 33, November 1941; *History of the First Air Force, Part II,* Chapter IV: "Engineer Training," Headquarters First Air Force, August 1946; "Vinsol Resin Stabilization," *AEN*, No 8, August 1942.

111 Craven and Cate, Vol 7: *Services Around the World*, 240.

112 "Vinsol Resin Stabilization," *AEN*, No 8, August 1942, 488-89; Craven and Cate, Vol 7: *Services Around the World*, 240.

113 Col. Stuart C. Godfrey, "Engineers with the Army Air Forces," *TME*, November 1941, Dwight F. Johns, "Maneuver Notes of Aviation Engineers," *TME*, November 1941, Vol 33, 495-496; Craven and Cate, Vol 7: *Services Around the World*, 241; Col. Dwight F. Johns, "Maneuver Notes of Aviation Engineers," *TME*, November 1941, Vol 33, 495-496; "Engineer Troop Activities," *TME*, Vol 33, December 1941, 583-584; Col. Dwight F. Johns, "Maneuver Notes of Aviation Engineers," *TME*, March 1942, Vol 33, 133-135; "Notes on the Carolina Maneuvers," *Notes on Aviation Engineers*, Air Force Combat Command Engineer Section, Bolling Field, Washington, D.C., 6 February 1942; "Commendation of Aviation Engineers," *AEN,* No 5, April 1942.

114 "Army: No More Phony Maneuvers," *Time*, 16 June 1941, n.p., accessed 4 October 2011, www.time.com.

115 Col. Dwight F. Johns, "Maneuver Notes of Aviation Engineers," *TME*, November 1941, Vol 33, 495-496; G. Patrick Murray, *The Louisiana Maneuvers: Practice for War*, The Journal of the Louisiana Historical Association, Spring 1972, Vol 13, No 2, 117.

116 Col. Dwight F. Johns, "Maneuver Notes of Aviation Engineers," *TME*, November 1941, Vol 33, 495-496; Blance D. Coll, Jean E. Keith, and Herbert Rosenthal, *The Corps of Engineers: Troops and Equipment*, Office of the Chief of Military History, United States Army, Washington, D.C., 1958, 129.

117 Col. Dwight F. Johns, "Maneuver Notes of Aviation Engineers," *TME*, November 1941, Vol 33, 495-496; "Big Maneuvers Test U.S. Army," *Life*, October 6, 1941, Vol 11, No 14, 33-43.

118 Christopher R. Gabel, *The U.S. Army GHQ Maneuvers of 1941*, Center of Military History, United States Army, Washington, D.C., 1992, 182.

119 Col. Stuart C. Godfrey, "Engineers with the Army Air Forces," *TME*, November 1941, Dwight F. Johns, "Maneuver Notes of Aviation Engineers," *TME*, November 1941, Vol 33, 495-496; Craven and Cate, Vol 7: *Services Around the World*, 241; Col. Dwight F. Johns, "Maneuver Notes of Aviation Engineers," *TME*, November 1941, Vol 33, 495-496; "Engineer Troop Activities," *TME*, Vol 33, December 1941, 583-584; Col. Dwight F. Johns, "Maneuver Notes of Aviation Engineers," *TME*, March 1942, Vol 33, 133-135; "Notes on the Carolina Maneuvers," *Notes on Aviation Engineers*, Air Force Combat Command Engineer Section, Bolling Field, Washington, D.C., 6 February 1942; "Commendation of Aviation Engineers," *AEN,* No 5, April 1942.

120 Capt. L. Dean Waggoner and 1st Lt. M. Allen Moe, "A History of Air Force Civil Engineering Wartime and Contingency Problems from 1941 to the Present," Thesis 85S-23, Air University, AFIT, WPAFB, Ohio, September 1985, 38.

121 Craven and Cate, Vol 7: *Services Around the World*, 244; Craven and Cate, Vol 6: *Men and Planes*, 43; Capt. L. Dean Waggoner and 1st Lt. M. Allen Moe, "A History of Air Force Civil Engineering Wartime and

Contingency Problems from 1941 to the Present," Thesis, Air University, AFIT, WPAFB, Ohio, 1985, 34-35, 39.

122 Craven and Cate, Vol 7: *Services Around the World*, 244; Craven and Cate, Vol 6: *Men and Planes*, 43; Capt. L. Dean Waggoner and 1st Lt. M. Allen Moe, "A History of Air Force Civil Engineering Wartime and Contingency Problems from 1941 to the Present," Thesis, Air University, AFIT, WPAFB, Ohio, 1985, 39-40.

123 Henry H. Arnold, *Global Mission*, Harper, New York, 1949, 211-212.

124 Craven and Cate, Vol 1: *Plans & Early Operations, January 1939 to August 1942*, 169.

125 Karl C. Dod, *United States Army in World War II, The Technical Services*, *The Corps of Engineers: The War Against Japan*, Office of the Chief of Military History, United States Army, Washington D.C., 1966, [hereafter cited as Dod]19, 22.

126 Stetson Conn, Rose Engelman, and Byron Fairchild, *Guarding the United States and Its Outposts,* Center of Military History, Washington, D.C., 2000, 229; Eagles Roost 247.

127 Dod, 7.

128 Brig. Gen. W. A. Danielson, "Wings Over Panama: A Defense Airfield in Panama's Jungle," *Quartermaster Review*, Jul-Aug 1941, 22-23, 83.

129 Dod, 9, 14-15.

130 Ibid. 29-30, 124-5.

131 Alfred M. Beck, et al., *United States Army in World War II, The Technical Services, The Corps of Engineers: The War Against Germany*, Office of the Chief of Military History, United States Army, Washington D.C., 1985, 10-16.

132 Ibid.

133 Ibid., 10-16; Alfred Goldberg, ed., *A History of the United States Air Force 1907-1957*, D. Van Nostrand Company, Inc., Princeton, New Jersey, 1957, reprint, Arno Press, Inc., New York, 1974, 53 (page citations are to the reprint edition).

134 Col. Joseph D Arthur, Jr., "Military Construction in the Atlantic Bases," *TME*, Vol 33, No 191, September 1941, 390-393; Dr. Charles Hendricks, "Building the Atlantic Bases: The Northern Route" *TME*, Vol 84, January-February 1992; Dr. Charles Hendricks, "Building the Atlantic Bases: The Southern Route," *TME*, Vol 84, March-April 1992.

135 Alfred Goldberg, ed., *A History of the United States Air Force 1907-1957*, D. Van Nostrand Company, Inc., Princeton, New Jersey, 1957, reprint, Arno Press, Inc., New York, 1974, 52 (page citations are to the reprint edition).

136 Craven and Cate, Vol 1: *Plans & Early Operations, January 1939 to August 1942*, 125.

137 Ibid.

138 Dod, 45.

139 Dod, 46-47.

140 Ibid. 61-63.

141 Ibid. 63.

142 Alfred M. Beck, et al., *United States Army in World War II, The Technical Services, The Corps of Engineers: The War Against Germany*, Office of the Chief of Military History, United States Army, Washington D.C., 1985, 44; Col. F. M. Albrecht, "Engineer Aspects of Operation Bolero," *TME*, Vol 42, March-April 1950, 116-120; "American Engineers Rush Bomber Bases in England," *AEN*, No 8, August 1942.

143 Alfred M. Beck, et al., *United States Army in World War II, The Technical Services, The Corps of Engineers: The War Against Germany*, Office of the Chief of Military History, United States Army, Washington D.C., 1985, 44.

144 Ibid. 46, 48.

145 Ibid.1985, 55.

146 Capt. L. Dean Waggoner and 1st Lt. M. Allen Moe, "A History of Air Force Civil Engineering Wartime and Contingency Problems from 1941 to the Present," Thesis 85S-23, Air University, AFIT, WPAFB, Ohio, September 1985, 40-41.

147 Alfred M. Beck, et al., *United States Army in World War II, The Technical Services, The Corps of Engineers: The War Against Germany*, Office of the Chief of Military History, United States Army, Washington D.C., 1985, 85.

148 AF Pamphlet 10-219, 9; Brig Gen Stuart Godfrey Memo, Headquarters AAF Directorate of Base Services, Engineer Section, to Commanding General, AAF, "Report on Airdromes and Aviation Engineers in North Africa," 4 January 1943

149 Alfred M. Beck, et al., *United States Army in World War II, The Technical Services, The Corps of Engineers: The War Against Germany*, Office of the Chief of Military History, United States Army, Washington D.C., 1985, 86.

150 "The Aviation Engineers in North Africa," *AEN*, No 14, August 1943; Brig Gen Stuart Godfrey Memo, Headquarters AAF Directorate of Base Services, Engineer Section, to Commanding General, AAF, "Report on Airdromes and Aviation Engineers in North Africa," 4 January 1943.

151 Alfred M. Beck, et al., *United States Army in World War II, The Technical Services, The Corps of Engineers: The War Against Germany*, Office of the Chief of Military History, United States Army, Washington D.C., 1985, 86-87; "Criteria for Dispersed Airdromes," *AEN*, No 8, August 1942, and No 14, August 1943.

152 "The Aviation Engineers in North Africa," *AEN,* No 14, August 1943; Alfred M. Beck, et al., *United States Army in World War II, The Technical Services, The Corps of Engineers: The War Against Germany*, Office of the Chief of Military History, United States Army, Washington D.C., 1985, 87; Craven and Cate, Vol 2: *Europe: Torch to Pointblank, August 1942 to December 1943*, 118.

153 Dr. Ronald B. Hartzer, "Nearly Indispensable: Aviation Engineers in North Africa," *Air Force Engineering & Services, Update*, Vol 2, No 9, November 1990, 12-13; "Wing Talk," *Collier's*, 18 December 1943.

154 Brig. Gen. Donald Davison, "Brigadier General Donald Davison Interview," 21 June 1943, unpublished manuscript at Air Force Historical Research Agency, Maxwell AFB, Alabama, 638.951; "Wing Talk," *Collier's*, 18 December 1943.

155 Craven and Cate, Vol 7: *Services Around the World*, 253.

156 Craven and Cate, Vol 2: *Europe: Torch to Pointblank, August 1942 to December 1943*, 561; Alfred M. Beck, et al., *United States Army in World War II, The Technical Services, The Corps of Engineers: The War Against Germany*, Office of the Chief of Military History, United States Army, Washington D.C., 1985, 90; HQ Army Air Force Engineer Command, MTO (Prov), A History of Policies Affecting Aviation Engineers in the Mediterranean Campaigns, Jan 1945, Air Force Historical Research Agency, Maxwell AFB, Alabama, Jan 1945.

157 "The Sicilian Operations," *AEN*, No 22, April 1944; Alfred M. Beck, et al., *United States Army in World War II, The Technical Services, The Corps of Engineers: The War Against Germany*, Office of the Chief of Military History, United States Army, Washington D.C., 1985, 446.

158 Alfred M. Beck, et al., *United States Army in World War II, The Technical Services, The Corps of Engineers: The War Against Germany*, Office of the Chief of Military History, United States Army, Washington D.C., 1985; Craven and Cate, Vol 7: *Services Around the World*, 254-256; *History of the Aviation Engineers in the Mediterranean Theater of Operations,"* Historical Section, AAF Engineer Command, MTO (P), 12 June 46, 165.

159 Craven and Cate, Vol 2: *Europe: Torch to Pointblank, August 1942 to December 1943*, 526; Historical Section, AAF Engineer Command, MTO(P), *History of the Aviation Engineers in the Mediterranean Theater of Operations,*12 June 1946, 191-195.

160 Craven and Cate, Vol 2: *Europe: Torch to Pointblank, August 1942 to December 1943*, 561; Craven and Cate, Vol 7: *Services Around the World*, 259, 262; AF Pamphlet 10-219, 10.

161 Craven and Cate, Vol 7: *Services Around the World*, 262.

162 Craven and Cate, Vol 2: *Europe: Torch to Pointblank, August 1942 to December 1943*, 561-562; Craven and Cate, Vol 7: *Services Around the World*, 263.

163 Craven and Cate, Vol 3: *Europe: Argument to V-E Day, January 1944 to May 1945*, 325, 345; Craven and Cate, Vol 7: *Services Around the World*, 264-265.

164 *The History of IX Engineer Command: From its beginning to V-E Day*, Schlangenbad, Germany 1945, 9-14; Office of Air Force History, Condensed Analysis of the Ninth Air Force in the European Theater of Operations, Office of Air Force History, Washington D.C., 1984, 10-11; AF Pamphlet 10-219, 10.

165 *The History of IX Engineer Command: From its beginning to V-E Day*, Schlangenbad, Germany 1945, 15-20; Craven and Cate, Vol 3: *Europe: Argument to V-E Day, January 1944 to May 1945*, 117-118; AF Pamphlet 10-219, 10; *Condensed Analysis of the Ninth Air Force in the European Theater of Operations*, Office of Air Force History, Washington, D.C. 1984, p 10.

166 Quoted in *Aviation Engineers in Mobile Warfare, IX Engineer Command*, IX Engineer Command, 1945, Air Force Historical Research Agency, Maxwell AFB, Alabama; History of IX Engineer Command, 48-60; Craven and Cate, Vol 3: *Europe: Argument to V-E Day, January 1944 to May 1945*, 131.

167 *History of IX Engineer Command*, 62; AF Pamphlet 10-219, 11.

168 Ibid., 62-4; AF Pamphlet 10-219, 12; Craven and Cate, Vol 3: *Europe: Argument to V-E Day, January 1944 to May 1945*, 563.

169 *History of IX Engineer Command*, 62-74; Craven and Cate, Vol 3: *Europe: Argument to V-E Day, January 1944 to May 1945*, 203-204; Craven and Cate, Vol 7: *Services Around the World*, 268; Col. R. E. Smyser, Jr., "Airfield Construction in France," *TME*, Vol 37, June 1945, 215.

170 *History of IX Engineer Command*, 66-7; Craven and Cate, Vol 3: *Europe: Argument to V-E Day, January 1944 to May 1945*, 204, 563, 565; AF Pamphlet 10-219, 12.

171 Craven and Cate, Vol 3: *Europe: Argument to V-E Day, January 1944 to May 1945*, 416-418, 426-434.

172 History of IX Engineer Command, 82-98; Craven and Cate, Vol 3: *Europe: Argument to V-E Day, January 1944 to May 1945*, 568; Craven and Cate, Vol 7: *Services Around the World*, 270; AF Pamphlet 10-219, 15; Second Report of the Commanding General of the Army Air Forces to the Secretary of War, 27 February 45; David Little, "Col. Augustine Patterson Little, Jr., Military History," available at http://macgruffus.com, accessed 21 December 2011.

173 "Fall and Winter Airfield Construction in France," *AEN*, No 34, April 1945; Craven and Cate, Vol 3: *Europe: Argument to V-E Day, January 1944 to May 1945*, 568, 571; Vernon Noble, "'Blitzed' Runways Made New," *TME*, Vol 37, March 1945, 8587.

174 History of IX Engineer Command, 100-2; Craven and Cate, Vol 3: *Europe: Argument to V-E Day, January 1944 to May 1945*, 547, 566.

175 Condensed Analysis, 108-9; Craven and Cate, Vol 3: *Europe: Argument to V-E Day, January 1944 to May 1945*, 570-571; Craven and Cate, Vol 7: *Services Around the World*, 272-273.

176 History of IX Engineer Command, 118-130; Craven and Cate, Vol 3: *Europe: Argument to V-E Day, January 1944 to May 1945*, 572.

177 History of IX Engineer Command, 130; AF Pamphlet 10-219, 15.

178 Dod, 53, 340-341.

179 Dod, 370; Dr. Ronald B. Hartzer, "Aviation Engineers Overcome Pacific Hardships," *Air Force Civil Engineer*, Vol 3, No 2, Summer 1995, 14.

180 Dod, 348-349, 370.

181 Ibid. 277-278.

182 Ibid. 281.

183 "An Engineer Job in the Aleutian Islands," *AEN*, No 14, August 1943; Dod, 186.

184 Dod, 285.

185 Ibid.

186 Dod, 286-287; "Amchitka Airstrip Built in 20 Days Despite Japs and Weather," *AEN,* No 15, September 1943; "Field Airdrome Construction by the 807th Engineer Aviation Battalion," *AEN*, No 21, March 1944.

187 Dod, 292, 330-331.

188 Ibid. 293-294, 296-297.

189 Ibid. 110, 136-38.

190 Lt. Col. Ralph C. Glover, *The History of the 808th Engineer Aviation Battalion*, SWPA File A167, Air Force Historical Research Agency, Maxwell AFB, Alabama.

191 Ibid.

192 Ibid.

193 Dod, 129-130.

194 William C. Baldwin, "Engineers in the Southwest Pacific, 1941-1944," *TME*, Vol 85, March-April 1993; Dr. Ronald B. Hartzer, "Aviation Engineers Overcome Pacific Hardships," *Air Force Civil Engineer*, Vol 3, No 2, Summer 1995, 14.

195 Dod, 125-26, 129-30.

196 Craven and Cate, Vol 4: *The Pacific: Guadalcanal to Saipan, August 1942 to July 1944*, 11-13.

197 Dod, 163-64.

198 Gen. George C. Kenney, *General Kenney Reports: A Personal History of the Pacific War*, Air Force History and Museums Program, Washington, D.C., 1997, 102; Dr. Ronald B. Hartzer, "Aviation Engineers Overcome Pacific Hardships," *Air Force Civil Engineer*, Vol 3, No 2, Summer 1995, 14.

199 William C. Baldwin, "Engineers in the Southwest Pacific, 1941-1944," *TME*, Vol 85, Mar-Apr 1993.

200 Karl C. Dod, *United States Army in World War II, The Technical Services*, *The Corps of Engineers: The War Against Japan*, Office of the Chief of Military History, United States Army, Washington D.C., 1966, 150-52.

201 Ibid. 150-52.

202 Lt. Col. Ralph C. Glover, *The History of the 808th Engineer Aviation Battalion*, SWPA File A167, Air Force Historical Research Agency, Maxwell AFB, Alabama, 102-103.

203 Karl C. Dod, *United States Army in World War II, The Technical Services*, *The Corps of Engineers: The War Against Japan*, Office of the Chief of Military History, United States Army, Washington D.C., 1966, 219-220.

204 Ibid. 186-187, 243.

205 Ibid. 206-207.

206 Ibid. 225, 227, 231.

207 Capt. Everette Frazier, *The Saga of Tsili Tsili*, E.E. Frazier, San Antonio, Texas, 1992; Capt. Everette Frazier, "Airfield Reconnaissance in New Guinea," *AEN,* No 33, March 1945; Warrant Officer William C. Hautz, "The Airborne Mission," *AEN*, Vol 15, September 1943, 3; Craven and Cate, Vol 4: *The Pacific: Guadalcanal to Saipan, August 1942 to July 1944*, 174-176; Craven and Cate, Vol 7: *Services Around the World*, 280.

208 William C. Baldwin, "Engineers in the Southwest Pacific, 1941-1944," *TME*, Vol 85, March-April 1993.

209 Dod, 380; Craven and Cate, Vol 4: *The Pacific: Guadalcanal to Saipan, August 1942 to July 1944*, 294.

210 Dod, 383-384; Dr. Harold T. Stearns, "Characteristics of Coral Deposits," *AEN,* No 28, October 1944.

211 Dr. Ronald B. Hartzer, "Aviation Engineers Overcome Pacific Hardships," *Air Force Civil Engineer*, Vol 3, No 2, Summer 1995, 14; Karl C. Dod, *United States Army in World War II, The Technical Services*, *The Corps of Engineers: The War Against Japan*, Office of the Chief of Military History, United States Army, Washington D.C., 1966; Capt. L. Dean Waggoner and 1st Lt. M. Allen Moe, "A History of Air Force Civil Engineering Wartime and Contingency Problems from 1941 to the Present," Thesis 85S-23, Air University, AFIT, WPAFB, Ohio, September 1985, 76-77.

212 Col. George E. White, "From Pearl Harbor to Tokyo," *TME*, Vol 38, January 1946, 1-8.

213 Craven and Cate, Vol 4: *The Pacific: Guadalcanal to Saipan, August 1942 to July 1944*, 693; AF Pamphlet 10-219, 17; Dr. Ronald B. Hartzer, "Aviation Engineers Overcome Pacific Hardships," *Air Force Civil Engineer*, Vol 3, No 2, Summer 1995, 14.

214 Craven and Cate, Vol 5: *The Pacific: Matterhorn to Nagasaki, June 1944 to August 1945*, 415, 523.

215 "Aviation Engineers on Saipan," *AEN*, No 32, February 1945; Dod, 518; Craven and Cate, Vol 5: *The Pacific: Matterhorn to Nagasaki, June 1944 to August 1945*, 517; Craven and Cate, Vol 7: *Services Around the World*, 305.

216 Craven and Cate, Vol 5: *The Pacific: Matterhorn to Nagasaki, June 1944 to August 1945*, 512-17; Lt. Col. Herbert E. Brown, Jr., "Aviation Engineers on Guam," *TME*, Vol 37, October 1945, 398-401.

217 Craven and Cate, Vol 5: *The Pacific: Matterhorn to Nagasaki, June 1944 to August 1945*, 518-19, 708.

218 Dod, 55.

219 Dod, 100-101, 105; AF Pamphlet 10-219, 16; Capt. Samuel A. Goldblith, "The 803d Engineers in the Philippine Defense," *TME*, Vol 38, August 1946, 323-325; Col. Jose A. Bernales and Perfecto M. Vasques, "Engineers in the Death March," *TME*, Vol 39, May 1947, 191-195.

220 Dod, 105-106; Louis Morton, *U.S. Army in World War II: The Fall of the Philippines*, Center of Military History, Washington, D.C., 1953.

221 Dod, 642-660; Col. John H. Dudley and Maj. William G. Staggs, "Engineer Troops on Airdrome Construction," *TME*, Vol 37, October 1945, 385-389.

222 Dod, 568.

223 Craven and Cate, Vol 5: *The Pacific: Matterhorn to Nagasaki, June 1944 to August 1945*, 448.

224 Dod, 579.

225 Dod, 579-80; Craven and Cate, Vol 5: *The Pacific: Matterhorn to Nagasaki, June 1944 to August 1945*, 373; Brig. Gen. S. D. Sturgis, Jr., "Engineer Operations in the Leyte Campaign," *TME*, Vol 39, November 1947, 457-462; *TME*, Vol 39, December 1947, 513-518; *TME*, Vol 40, January 1948, 15-19.

226 Maj. W. G. Caples, "Airfield Construction on Leyte," *AEN,* No 33, March 1945; Dod, 583.

227 Craven and Cate, Vol 5: *The Pacific: Matterhorn to Nagasaki, June 1944 to August 1945*, 398, 400-401, 443-444.

228 Dod, 582, 598-600.

229 Craven and Cate, Vol 5: *The Pacific: Matterhorn to Nagasaki, June 1944 to August 1945*, 445.

230 AF Pamphlet 10-219, 17; Craven and Cate, Vol 5: *The Pacific: Matterhorn to Nagasaki, June 1944 to August 1945*, 447; Craven and Cate, Vol 7: *Services Around the World*, 291, 293.

231 Dod, 389, 393-394.

232 Ibid. 429.

233 Dod, 427; Craven and Cate, Vol 7: *Services Around the World*, 301; Donovan Webster, *The Burma Road: The Epic Story of the China-Burma-India Theater*, Farrar, Straus & Giroux, New York, 2003.

234 Brig. Gen. Stuart Godfrey, "Glider-Borne Engineers," *AEN*, No 24, June 1944; Dod, 445-446.

235 Dod, 445-446; Headquarters First Air Force, *Arms and Services, February 1941 to December 1944*, Vol I, Chapter IV, "Engineer Training," Air Force Historical Research Agency, Maxwell AFB, Alabama; Capt. Stephen A. Derry, "Airborne Engineers," *TME*, Vol 35, September 1943; Capt. Ed J. Flynn, "Airborne Engineer Training," *TME*, Vol 36, November 1944, 359-363; "Training Missions of Airborne Engineers," *AEN,* No 15, September 1943; "Special Projects of I Troop Carrier Command, Part I: The Training of Airborne Engineer Aviation Battalions Within I Troop Carrier Command," Headquarters IX Troop Carrier Command, November 1945.

236 Craven and Cate, Vol 7: *Services Around the World*, 301-302; Dod, 455; Leslie Anders, "The Engineers at Myitkyina," *TME*, Vol 44, November-December 1952, 446-450.

237 Craven and Cate, Vol 7: *Services Around the World*, 301-302; Karl C. Dod, *United States Army in World War II, The Technical Services*, *The Corps of Engineers: The War Against Japan*, Office of the Chief of Military History, United States Army, Washington D.C., 1966, 455.

238 Dod, 302.

239 Dod, 442, 450; Leslie Anders, "Building the Dudhkundi Air Base," *TME*, Vol 45, September-October 1953, 355-356.

240 Ulysses Lee, *The Employment of Negro Troops*, Office of the Chief of Military History, U.S. Army, 1966.

241 Craven and Cate, Vol 7: *Services Around the World*, 299; Craven and Cate, Vol 5: *The Pacific: Matterhorn to Nagasaki, June 1944 to August 1945*, 351.

242 Craven and Cate, Vol 5: *The Pacific: Matterhorn to Nagasaki, June 1944 to August 1945*, 404.

243 Craven and Cate, Vol 7: *Services Around the World*, 299; Craven and Cate, Vol 5: *The Pacific: Matterhorn to Nagasaki, June 1944 to August 1945*, 62.

244 James W. Dunn, "The Ledo Road," in Barry W. Fowle, ed., *Builders and Fighters: U.S. Army Engineers in World War II*, Office of History, United States Army Corps of Engineers, Fort Belvoir, Virginia, 1992, 327-346.

245 Ibid. 327-346.

246 Ibid. 327-346.

247 James W. Dunn, "The Ledo Road," in Barry W. Fowle, ed., *Builders and Fighters: U.S. Army Engineers in World War II*, Office of History, United States Army Corps of Engineers, Fort Belvoir, Virginia, 1992, 327-346; Karl C. Dod, *United States Army in World War II, The Technical Services*, *The Corps of Engineers: The War Against Japan*, Office of the Chief of Military History, United States Army, Washington D.C., 1966,

664.

248 James W. Dunn, "The Ledo Road," in Barry W. Fowle, ed., *Builders and Fighters: U.S. Army Engineers in World War II*, Office of History, United States Army Corps of Engineers, Fort Belvoir, Virginia, 1992, 327-346.

249 Ibid. 327-346.

250 James W. Dunn, "The Ledo Road," in Barry W. Fowle, ed., *Builders and Fighters: U.S. Army Engineers in World War II*, Office of History, United States Army Corps of Engineers, Fort Belvoir, Virginia, 1992, 327-346; Craven and Cate, Vol 7: *Services Around the World*, 300; Dod, 662-664.

251 Craven and Cate, Vol 7: *Services Around the World*, 429, 440; Dod, 451; Ernest Hemingway, "How 100,000 Chinese Built an Airport," *AEN*, No 8, August 1942.

252 Dr. Ronald B. Hartzer, "Aviation Engineers Overcome Pacific Hardships," *Air Force Civil Engineer*, Vol 3, No 2, Summer 1995; Craven and Cate, Vol 7: *Services Around the World*, 71.

253 Dod, 468-469.

254 Craven and Cate, Vol 7: *Services Around the World*, 303-304.

255 Craven and Cate, Vol 5: *The Pacific: Matterhorn to Nagasaki, June 1944 to August 1945*, 596.

256 Ibid. 596-598.

257 Craven and Cate, Vol 5: *The Pacific: Matterhorn to Nagasaki, June 1944 to August 1945*, 691; "First All-American Runway in the Ryukyus Islands," *Aviation Engineer Notes*, No 40, October 1945.

258 Craven and Cate, Vol 5: *The Pacific: Matterhorn to Nagasaki, June 1944 to August 1945*, 692.

259 Ibid. 691, 683, 695-697; Craven and Cate, Vol 7: *Services Around the World*, 307.

260 Craven and Cate, Vol 5: *The Pacific: Matterhorn to Nagasaki, June 1944 to August 1945*, 538.

261 Ibid. 692; AF Pamphlet 10-219, 17.

262 Office of the Air Engineer, HQ USAF, "Aviation Engineers: From Origin to Termination of World War II," circa 1947, AHO; Capt. L. Dean Waggoner and 1st Lt. M. Allen Moe, "A History of Air Force Civil Engineering Wartime and Contingency Problems from 1941 to the Present," Thesis, Air University, AFIT, WPAFB, Ohio, 1985, 35.

263 Craven and Cate, Vol 6: *Men and Planes*, 120.

264 Capt. Cecil L. Reynolds, Historian, "Construction for United States Air Forces in Europe, 8 May 1945-1 July 1947," Headquarters USAFE, 1 August 1948, 45,46, 63-66.

265 Ibid. 124-126, 137-141, 146.

266 Ibid. 26-27.

267 Ibid. 40, 45-46, 59.

268 Ibid. 60, 117-118.

269 Dr. William C. Baldwin, "Army Engineers in Post-War Reconstruction: The Philippines, Japan, and Germany, 1945-1947," Office of History, Headquarters U.S. Army Corps of Engineers, n.d.

270 Ibid.

271 Ibid.

272 Ibid.

273 War Department Adjutant General's Office to Brig. Gen. George J. Nold, Letter, "Board of Officers to Review Engineer Aviation Experiences, World War II," 3 July 1946; Brig. Gen. Reuben C. Hood, Deputy Chief of Air Staff, to Board of Officers Appointed by War Department, Letter Order AGPC-A-G 334, "Study of Aviation Engineers in Support of Army Air Forces," 8 July 1946.

274 "Report of a Board of Officers on Aviation Engineers," submitted to the Commanding General, AAF, 29 July 1946, Tab B, 3, AHO.

275 "Analysis of Aviation Engineer Board Report Recommendations and Comments," n.d., AHO.

276 Ibid.

277 Ibid.

278 Herman Wolk, *Planning and Organizing the Postwar Air Force 1943-1947*, Office of Air Force History, Washington, D.C., 1984, 36, 98, 210, 214.

279 Shaw, 42-43; Herman Wolk, *Planning and Organizing the Postwar Air Force 1943-1947*, Office of Air Force History, Washington, D.C., 1984, v.

280 Herman Wolk, *Planning and Organizing the Postwar Air Force 1943-1947*, Office of Air Force History, Washington, D.C., 1984, 134, 139; "Organization and Functions of Engineers in Autonomous AF," n.d., *ca*. May 1947, 10-11.

281 Shaw, 43.

Chapter 2 Endnotes

1 Frederick J. Shaw, ed., *Locating Air Force Base Sites, History's Legacy,* Air Force History and Museum Program, Washington, D.C., 2004, 53.

2 Lt. Col. Bernard Card, "The Role of Engineers in the Air Force," Research report, Air War College, Maxwell AFB, Alabama, 1948, 68, 61-62.

3 Brig. Gen. S. D. Sturgis, Jr., "Engineers in an Autonomous AAF," staff letter, 17 May 1946, Files of AFCEC History Office, Tyndall AFB, Florida [hereafter cited as AHO]; "Organization and Functions of Engineers in Autonomous AF," 6 Jun 1946, AHO; *Air Engineer Plan for Engineer Service in the United States Air Force*, 1 May 1947, AHO.

4 Lt. Col. Bernard Card, "The Role of Engineers in the Air Force," Research report, Air War College, Maxwell AFB, Alabama, 1948, 86, 93.

5 *Air Engineer Plan for Engineer Service in the United States Air Force*, 1 May 1947, AHO.

6 Ibid; Herman Wolk, *Planning and Organizing the Postwar Air Force 1943-1947*, Office of Air Force History, 1984, 76, 78.

7 United States Congress, U.S. Public Law 253, 80th Congress, 1st Session, 26 July 1947.

8 Air University, *Legislative History of the AAF and USAF 1941-1951*, USAF Historical Studies: No.84. USAF Historical Division, Research Studies Institute, September 1955, 57, 59.

9 Ibid. 59.

10 Richard I. Wolf, *The United States Air Force: Basic Documents on Roles and Missions,* Office of Air Force History, Washington, D.C., 1987, 73-75, 116-117; Col. Robert H. Curtin, "Air Force Construction, Its Organization and Planning," Thesis, Air War College, Air University, Maxwell AFB, Alabama, 1954, 6.

11 Col. Robert H. Curtin, "Air Force Construction, Its Organization and Planning," Thesis, Air War College, Air University, Maxwell AFB, Alabama, 1954, 6; Richard I. Wolf, *The United States Air Force: Basic Documents on Roles and Missions,* Office of Air Force History, Washington, D.C., 1987, 116.

12 Richard I. Wolf, *The United States Air Force: Basic Documents on Roles and Missions,* Office of Air Force History, Washington, D.C., 1987, 116-117; Lt. Col. Floyd Ashdown, "A History of the Warfighting Capability of Air Force Civil Engineering," Research Report, Air University, Maxwell AFB, Alabama, 1984 [hereafter cited as Ashdown], 9; Herman Wolk, *Planning and Organizing the Postwar Air Force 1943-1947*, Office of Air Force History, 1984, 207.

13 Richard I. Wolf, *The United States Air Force: Basic Documents on Roles and Missions,* Office of Air Force History, Washington, D.C., 1987, 98; Herman Wolk, *Planning and Organizing the Postwar Air Force 1943-1947*, Office of Air Force History, 1984, 95.

14 Ashdown, 10-11; Lenox R. Lohr, "Engineer Shortage and National Security," *The Military Engineer* [hereafter cited as *TME*], Vol 46, No 313, September-October 1954, 343-345; Letter to Editor by Maj. Gen. Lee B. Washbourne, *TME*, Vol 46, No 314, November-December 1954, 439; "The Shortage of Technical Manpower: A Summary," *TME*, Vol 47, No 317, May-June 1955, 199-203.

15 Alfred Goldberg, ed., *A History of the United States Air Force 1907-1957*, D. Van Nostrand Company, Inc., Princeton, New Jersey, 1957, reprint, Arno Press, Inc., New York, 1974, 106; Air University, *Legislative History of the AAF and USAF 1941-1951*, USAF Historical Studies: No. 84. USAF Historical Division, Research Studies Institute, September 1955, 59.

No.84. USAF Historical Division, Research Studies Institute, September 1955, 65-66.

16 Air University, *Legislative History of the AAF and USAF 1941-1951*, USAF Historical Studies: No. 84. USAF Historical Division, Research Studies Institute, September 1955, 65-66.

17 Directorate of Installations History, July-December 1950, n.p., AHO; Wolk, *Planning and Organizing the Postwar Air Force,* 203-204.

18 Air University, *Legislative History of the AAF and USAF 1941-1951*, USAF Historical Studies: No. 84. USAF Historical Division, Research Studies Institute, September 1955, 66, 69-70; *Air Reserve Forces Review Magazine*, November 1951, 10.

19 W. Stuart Symington, "Military Engineers in the Air World of Tomorrow," *TME,* Vol 39, No 266 , December 1947, 4.

20 E.R. Jackson, "The Engineer Segment within the Air Force," *TME*, Vol 41, No 279, January-February 1949, 42; "AFIRO," *TME*, Vol 50, No 334, March-April 1958, 137; Directorate of Installations History, 1 Jul 1949 to 30 June 1950, n.p., AHO; George K. Dimitroff, "A Chronicle of Progress, 1960-1969," *Air Force Civil Engineer*, Vol 11, No 1, February 1970, 2.

21 E.R. Jackson, "The Engineer Segment within the Air Force," *TME*, Vol 41, No 279, January-February 1949, 42.

22 Directorate of Installations History, July 1949 to 30 June 1950, n.p., AHO.

23 E.R. Jackson, "The Engineer Segment within the Air Force," *TME*, Vol 41, No 279, January-February 1949, 42.

24 "Air Force Engineer Staff," *TME*, Vol 40, No 276, October 1948, 473.

25 Brig. Gen. William Leonhard (USAF, Retired), "Oral History Interview," Interviewed by John Lonnquest, Office of History, Headquarters U.S. Army Corps of Engineers, August 2000, October 2001, 27-28.

26 Maj. Gen. Robert H. Curtin (USAF, Retired), "Oral History Interview," Interviewed by Lois E. Walker

and Dr. Ronald B. Hartzer, HQ AFCESA, Tyndall AFB, Florida, December 2003, 17-18; Brig. Gen. Archie S. Mayes (USAF, Retired), "Oral History Interview," Interviewed by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, May 2006, 31-32; Brig. Gen. John D. Peters (USAF, Retired), "Oral History Interview," Interviewed by Lois E. Walker and Dr. Ronald B. Hartzer, HQ AFCESA, Tyndall AFB, Florida, June 2001, 10-11.

27 Air Force Civil Engineer Manpower, AHO.

28 U.S. Air Force Biographies: Brig. Gen. Robert Kauch, Maj. Gen. Colby M. Myers, Maj. Gen. Grandison Gardner, Lt. Gen. Patrick W. Timberlake, U.S. Air Force, accessed various dates, www.af.mil/information/bios.

29 Lois E. Walker, "A Tradition of Excellence," *The CE*, Vol 7, No 2, Summer 1999, 35.

30 *Installations Engineer Beacon*, Vol 30, September 1956, 1.

31 Directorate of Installations History, 1 July 1949-30 June 1950, January-June 1951, n.p., AHO.

32 Col. Robert H. Curtin, "Air Force Construction, Its Organization and Planning," Thesis, Air War College, Air University, Maxwell AFB, Alabama, 1954, 198.

33 General Order 84, 28 December 1951.

34 U.S. Air Force Biographies: Maj. Gen. Lee Bird Washbourne, U.S. Air Force, accessed various dates, www.af.mil/information/bios; "Know Your Boss," *Installations Engineer Beacon*, Vol 18, August 1955, 1.

35 Directorate of Installations History, 1 July-31 December, 1952, n.p., AHO; *Installations Engineer Beacon*, Vol 13, March 1955, 1.

36 "Office, Assistant Chief of Staff, Installations, Headquarters, United States Air Force," *TME*, Vol 48, No 322, March-April 1956, 118-119; Assistant Chief of Staff, Installations History, 1 January -30 January 1954, AHO; Arlie C. Huffman, "Development of the Air Force Civil Engineering Function, 1918-Present," May 1962, AHO.

37 *Installations Engineer Beacon*, Vol 38, May 1957, 1.

38 General Order 36, 27 June 1957.

39 "The Directorate of Installations, Headquarters, United States Air Force," *TME*, Vol 50, No 335, May-June 1958, 197-198.

40 Assistant Chief of Staff, Installations History, January-June 1957, n.p., AHO.

41 Fred Hamlin, "Can Air Force Bases Stay in Step?," *Armed Forces Management*, November 1958, 12-14.

42 "What's Ahead: Interview with Maj. Gen. M.R. Reilly," *Air Force Civil Engineer*, Vol 15, No 1, February 1974, 8-9.

43 Directorate of Installations Histories, July 1949-June 1950 and January-June 1951, n.p., AHO; Frederick J. Shaw, ed., *Locating Air Force Base Sites, History's Legacy,* Air Force History and Museum Program, Washington, D.C., 2004, 54-55.

44 "Air Force Facilities," *TME,* Vol 40, No 277, November 1948, 517.

45 Brig. Gen. William T. Meredith (USAF, Retired), "Oral History Interview," Interviewed by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, 2001, vi, 35, 38-39.

46 "Meet…John R. Gibbens," *Air Force Civil Engineer*, Vol 3, No 1, February 1962, n.p.; "Deputy Air Force Civil Engineers," *Air Force Civil Engineer*, Vol 19, No 4, 2011, 7.

47 Brig. Gen. William T. Meredith (USAF, Retired), "Oral History Interview," Interviewed by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, 2001, 38-39.

48 Brig. Gen. William T. Meredith (USAF, Retired), "Oral History Interview," Interviewed by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, 2001, 39-41.

49 Col. Robert H. Curtin, "Air Force Construction, Its Organization and Planning," Thesis, Air War College, Air University, Maxwell AFB, Alabama, 1954, iii, ix, 3.

50 Ibid. 27-30, 36-49, 26.

51 Ibid.

52 Ibid. 36-49, 26.

53 Directorate of Installations History, January-June 1951, n.p., AHO; Col. Robert H. Curtin, "Air Force Construction, Its Organization and Planning," Thesis, Air War College, Air University, Maxwell AFB, Alabama, 1954, 96-99.

54 Col. Robert H. Curtin, "Air Force Construction, Its Organization and Planning," Thesis, Air War College, Air University, Maxwell AFB, Alabama, 1954, 99-100; Brig. Gen. William T. Meredith (USAF, Retired), "Oral History Interview," Interviewed by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, 2001, 39-41.

55 Col. Robert H. Curtin, "Air Force Construction, Its Organization and Planning," Thesis, Air War College, Air University, Maxwell AFB, Alabama, 1954, 101-104; Alfred Goldberg, editor, *A History of the United States Air Force*, Arno Press, New York, reprint edition, 1974, 191.

56 *Installations Engineer Beacon*, Vol 8, October 1954, 5.

57 *Installations Engineer Beacon*, Vol 6, August 1954, 1; *Installations Engineer Beacon*, Vol 13, March 1955, 4.

58 Directorate of Installations History July-December 1959, n.p., AHO.

59 Brig. Gen. William T. Meredith (USAF, Retired), "Oral History Interview," Interviewed by Lois E. Walker , HQ AFCESA, Tyndall AFB, Florida, 2001, 41-42.

60 Assistant Chief of Staff, Installations History, July-December 1954, n.p., AHO; *Installations Engineer Beacon*, Vol 9, October 1954, 1.

61 "Air Engineer Notes," *TME*, Vol 47, No 320, November-December 1955, 478-479; "Air Force Installations Conference," *TME*, Vol 48, No 322, March-April, 1956, 144.

62 Chronology of Significant Historical Events in Air Force Civil Engineering, files of Dr. Ronald B. Hartzer, HQ AFCESA, Tyndall AFB, Florida; Air Staff History Jul-Dec 54; "Air Engineer Notes," *TME*, November-December 1955, 478-479; "Air Force Installations Conference," *TME*, March-April, 1956, 144.

63 *Installations Engineer Beacon*, Vol 33, December 1956, 1.

64 Assistant Chief of Staff, Installations, January-June 1956, AHO; Fred Hamlin, "Can Air Force Bases Stay in Step?," *Armed Forces Management*, November 1958, 12-14; Dr. Ronald B. Hartzer, "History Lesson: What's In a Name?," *The U.S. Air Force Civil Engineer*, Vol 2, No 2, March 1994, 2-3.

65 Maj. Gen. Augustus M. Minton, (USAF, Retired), "Oral History Interview," Interview by Dr. Ronald B. Hartzer and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, June 2001, iii-iv; *Installations Engineer Beacon*, Vol 38, May 1957, 1.

66 Maj. Gen. Augustus A. Minton, "Message from the director…," *Air Force Civil Engineer*, Vol 1, No 2, May 1960, 2.

67 George K. Dimitroff, Editor, "A Chronicle of Progress 1960-1969, *Air Force Civil Engineer*, Vol 11, No 1, February 1970, 2.

68 Ibid. 3.

69 Anders, James M. "Preparatory Assistance Available for AFRCEs Seeking Registration as Professional Engineers," *Civil Engineering Beacon*, Vol 6, No 60, August-September-October, 1959, 3-4.

70 Ibid. 4-5.

71 Directorate of Installations, History, January-June 1951, n.p., AHO.

72 Col. Robert H. Curtin, "Air Force Construction, Its Organization and Planning," Thesis, Air War College, Air University, Maxwell AFB, Alabama, 1954, 93-94; Directorate of Installations History January-June 1951, 31-33, AHO; Alfred Goldberg, ed., *A History of the United States Air Force 1907-1957*, D. Van Nostrand Company, Inc., Princeton, New Jersey, 1957, reprint, Arno Press, Inc., New York, 1974, 189-190; Merrill De Longe, "Effects of Jet Aircraft on Air Base Planning," *TME*, Vol 48, No 326, November-December 1956, 420-422; Directorate of Installations History, January-June 1951, n.p., AHO.

73 Col. Robert H. Curtin, "Air Force Construction, Its Organization and Planning," Thesis, Air War College, Air University, Maxwell AFB, Alabama, 1954, 7-10.

74 Col. Edwin M. Eads, "The Air Force Installations Representatives," *TME*, Vol 48, No 325, September-October 1956, 362-363.

75 Directorate of Installations History, 1 July 1949-30 June 1950, July-December 1950, January-June 1951, July-December 1951, January-June 1952, n.p., AHO; Col. Edwin M. Eads, "The Air Force Installations Representatives," *TME*, Vol 48, No 325, September-October 1956, 362-363; Col. Robert H. Curtin, "Air Force Construction, Its Organization and Planning," Thesis, Air War College, Air University, Maxwell AFB, Alabama, 1954, 139.

76 Directorate of Installations History, 1 January-30 June 1952, n.p., AHO.

77 Continental Air Command, "Air Installations Volume I, ConAC Manual 50-10," 1952, 8.

78 Directorate of Installations History, 1 January-30 June 1952, n.p., AHO.

79 Air Force Regulation 93-17, *Installations-Control Procedures*, 23 June 1954.

80 Directorate of Installations History, 1 January-30 June 1954, n.p., AHO.

81 Directorate of Installations History, 1 January-30 June 1954, n.p., AHO.

82 Air Force Regulation 93-17, *Installations-Control Procedures*, 23 April 1957.

83 Col. Edwin M. Eads, "The Air Force Installations Representatives," *TME*, Vol 48, No 325, September-October 1956, 362-363.

84 Col. Robert H. Curtin, "Air Force Construction, Its Organization and Planning," Thesis, Air War College, Air University, Maxwell AFB, Alabama, 1954, 108.

85 Ibid. 1954, 109.

86 Ibid. 109.

87 Col. Robert H. Curtin, "Air Force Construction, Its Organization and Planning," Thesis, faculty of the Air War College, Air University, Maxwell AFB, Alabama, 1954, 32; Air Force Regulation 85-5, *Maintenance of Installations*, 30 June 1951, 1.

88 Directorate of Installations History, July-December 1950, n.p.; AHO.

89 "Planning Buildings for the U.S. Air Force," *Architectural Record*, Vol 111, No 1, January 1952, 96-97.

90 Ibid, 97.

91 Directorate of Installations History, January-June 1951, n.p., AHO; *Installations Engineer Beacon*, Vol 11, January 1955, 6; *Installations Engineer Beacon*, Vol 21, November 1955, 3; *Installations Engineer Beacon*, Vol 6, No 60, August-October 1959, 2; *Installations Engineer Beacon*, Vol 13, March 1955, 7.

92 *Installations Engineer Beacon*, Vol 6, No 60, August-October 1959, 2; *Installations Engineer Beacon*, Vol 13, March 1955, 7; Assistant Chief of Staff, Installations History, July-December 1956, n.p., AHO; Lt. Col. J. N. Kruppa, "Definitive Design in the Air Force," *TME*, Vol 49, No 330, July-August 1957, 261.

93 Col. Robert H. Curtin, "Air Force Construction, Its Organization and Planning," Thesis, Air War College, Air University, Maxwell AFB, Alabama, 1954, 32-33.

94 Directorate of Installations History, July-December 1951, n.p., AHO

95 Col. Robert H. Curtin, “Air Force Construction, Its Organization and Planning,” Thesis, Air War College, Air University, Maxwell AFB, Alabama, 1954, 32-33; *Installations Engineer Beacon*, Vol 26, April 1956, 4.

96 Col. Robert H. Curtin, “Air Force Construction, Its Organization and Planning,” Thesis, Air War College, Air University, Maxwell AFB, Alabama, 1954, 32-33; *Installations Engineer Beacon*, Vol 26, April 1956, 4.

97 Assistant Chief of Staff, Installations History, July-December 1954, n.p.; Assistant Chief of Staff, Installations History, January-June 1955, n.p.

98 Maj. Gen. Charles G. Holle, “Military Engineering for Modern Warfare,” *TME,* Vol 48, No 325, September-October 1956, 333-336; Merrill De Longe, “Effects of Jet Aircraft on Air Base Planning,” *TME*, Vol 48, No 326, November-December 1956, 420-422; Assistant Chief of Staff, Installations History, January-June 1956, n.p.; Alfred Goldberg, ed., *A History of the United States Air Force 1907-1957*, D. Van Nostrand Company, Inc., Princeton, New Jersey, 1957, reprint, Arno Press, Inc., New York, 1974, 195; Dr. Ronald B. Hartzer, “An Interview with Maj. Gen. Augustus M. Minton,” *The CE*, Vol 4, No 2, Summer 1996, 9.

99 Assistant Chief of Staff, Installations History, January-June 1957, AHO.

100 *Installations Engineering Beacon*, Vol 8, October 1954, 5.

101 Assistant Chief of Staff, Installations History, January-June 1957, AHO; Directorate of Installations History, January-June 1958, n.p., AHO.

102 Directorate of Installations History, January-June 1958, January-June 1959, n.p., AHO.

103 Directorate of Installations History, January-June 1959, July-December 1959, n.p., AHO.

104 Directorate of Installations History, January-June 1951, July-December 1951, July-December 1953, July-December 1954, n.p., AHO.

105 Kirsten Peeler, Christine Heidenrich, Katherine E. Grandine, and Dean A. Doerrfeld, “Housing an Air Force and a Navy: The Wherry and Capehart Solutions to the Postwar Family Housing Shortage (1949-1962),” prepared for the United States Department of the Air Force and the United States Department of the Navy by R. Christopher Goodwin and Associates, Inc., Frederick, Maryland, June 2007, 17-19.

106 Ibid. 21-22, 54.

107 Col. Guy H. Goddard, “Air Force Builds Its Own Family Housing,” *Air Force Civil Engineer*, Vol 1, No 3, August 1960, n.p.

108 William C. Baldwin, “Wherry and Capehart: Army Family Housing Privatization Programs in the 1950s,” *Engineer*, April 1996, 42-44; Kirsten Peeler, Christine Heidenrich, Katherine E. Grandine, and Dean A. Doerrfeld, “Housing an Air Force and a Navy: The Wherry and Capehart Solutions to the Postwar Family Housing Shortage (1949-1962),” prepared for the United States Department of the Air Force and the United States Department of the Navy by R. Christopher Goodwin and Associates, Inc., Frederick, Maryland, June 2007, 69,70.

109 Kirsten Peeler, Christine Heidenrich, Katherine E. Grandine, and Dean A. Doerrfeld, “Housing an Air Force and a Navy: The Wherry and Capehart Solutions to the Postwar Family Housing Shortage (1949-1962),” prepared for the United States Department of the Air Force and the United States Department of the Navy by R. Christopher Goodwin and Associates, Inc., Frederick, Maryland, June 2007, 83.

110 Directorate of Installations History, July 1949-June 1950; July-December 1953, n.p., AHO.

111 William C. Baldwin, “Wherry and Capehart: Army Family Housing Privatization Programs in the 1950s,” *Engineer*, April 1996, 42-44.

112 Kirsten Peeler, Christine Heidenrich, Katherine E. Grandine, and Dean A. Doerrfeld, “Housing an Air Force and a Navy: The Wherry and Capehart Solutions to the Postwar Family Housing Shortage (1949-1962),” prepared for the United States Department of the Air Force and the United States Department of the Navy by R. Christopher Goodwin and Associates, Inc., Frederick, Maryland, June 2007, 71-72, 74-77; Directorate of Installations History 1951, n.p., AHO.

113 *Installations Engineer Beacon*, Vol 4, June 1954, 3.

114 William C. Baldwin, “Wherry and Capehart: Army Family Housing Privatization Programs in the 1950s,” *Engineer*, April 1996, 44; Kirsten Peeler, Christine Heidenrich, Katherine E. Grandine, and Dean A. Doerrfeld, “Housing an Air Force and a Navy: The Wherry and Capehart Solutions to the Postwar Family Housing Shortage (1949-1962),” prepared for the United States Department of the Air Force and the United States Department of the Navy by R. Christopher Goodwin and Associates, Inc., Frederick, Maryland, June 2007, 83.

115 Col. Rio G. Lucas (USAF, Retired), “Oral History Interview,” interviewed by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, July 1999, 24-25.

116 Air Staff History July-December 1959, AHO.

117 Kirsten Peeler, Christine Heidenrich, Katherine E. Grandine, and Dean A. Doerrfeld, “Housing an Air Force and a Navy: The Wherry and Capehart Solutions to the Postwar Family Housing Shortage (1949-1962),” prepared for the United States Department of the Air Force and the United States Department of the Navy by R. Christopher Goodwin and Associates, Inc., Frederick, Maryland, June 2007, 91.

118 Maj. Gen. Augustus M. Minton (USAF, Retired), “Oral History Interview,” Interviewed by Lois E. Walker and Dr. Ronald B. Hartzer, HQ AFCESA, Tyndall AFB, Florida, June 2001, 26.

119 Maj. Gen. Guy H. Goddard (USAF, Retired), “Oral History Interview,” Interviewed by Dr. Ronald B. Hartzer and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, February 2003, 7.

120 Maj. Gen. William D. Gilbert (USAF, Retired), "Oral History Interview," Interviewed by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, September 2002, 42.

121 Kirsten Peeler, Christine Heidenrich, Katherine E. Grandine, and Dean A. Doerrfeld, "Housing an Air Force and a Navy: The Wherry and Capehart Solutions to the Postwar Family Housing Shortage (1949-1962)," prepared for the United States Department of the Air Force and the United States Department of the Navy by R. Christopher Goodwin and Associates, Inc., Frederick, Maryland, June 2007, 116.-117.

122 Col. Rio G. Lucas (USAF, Retired) "Oral History Interview," Interviewed by Mrs. Lois E. Walker, HQ AFCESA, Tyndall, AFB, Florida, July 1999, 25-26.

123 Colonel Guy H. Goddard, "Air Force Builds Its Own Family Housing," *Air Force Civil Engineer*, August 1960.

124 Kirsten Peeler, Christine Heidenrich, Katherine E. Grandine, and Dean A. Doerrfeld, "Housing an Air Force and a Navy: The Wherry and Capehart Solutions to the Postwar Family Housing Shortage (1949-1962)," prepared for the United States Department of the Air Force and the United States Department of the Navy by R. Christopher Goodwin and Associates, Inc., Frederick, Maryland, June 2007, 2.

125 Directorate of Installations History, July 1949-June 1950, July-December 1950, n.p., AHO.

126 Directorate of Installations History, July 1949-June 1950, July-December 1950, January-June 1952, n.p., AHO; Assistant Chief of Staff, Installations History, July-December 1952, n.p., AHO.

127 Mandy Wharton, "The Cultural Significance of the U.S. Air Force Defensive Radar System," paper for session at WAC4, Jan 1999.

128 Haile, John and Ron Dalby, *Top Cover and Global Engagement: A History of the Eleventh Air Force.* Alaska Quality Publishing, Anchorage, Alaska, 2001.

129 Ibid.

130 Assistant Chief of Staff, Installations History, 1952 to 1954, AHO.

131 Assistant Chief of Staff, Installations History, 1952 to 1954, AHO; Walter Boyne, "The Rise of Air Defense," *Air Force Magazine*, December 1999.

132 Alfred Goldberg, ed., *A History of the United States Air Force 1907-1957*, D. Van Nostrand Company, Inc., Princeton, New Jersey, 1957, reprint, Arno Press, Inc., New York, 1974, 133-135, 193-194; David F. Winkler, "Searching the Skies: The Legacy of the United States Cold War Defense Radar Program," 1997, 26, 33, Prepared by U.S. Army Construction Engineering Research Laboratories for Headquarters Air Combat Command.

133 Assistant Chief of Staff, Installations History, July-December 1954, n.p., AHO; Alfred Goldberg, ed., *A History of the United States Air Force 1907-1957*, D. Van Nostrand Company, Inc., Princeton, New Jersey, 1957, reprint, Arno Press, Inc., New York, 1974, 193-194.

134 Alfred Goldberg, ed., *A History of the United States Air Force 1907-1957*, D. Van Nostrand Company, Inc., Princeton, New Jersey, 1957, reprint, Arno Press, Inc., New York, 1974, 193.

135 Richard E. Goodman, *Karl Terzaghi. The Engineer as Artist*, ASCE Press, 1999, 216; W. Marks Jaillite, "Permafrost Research Area," *TME*, Vol 39, No 263, September 1947, 375; Col. Walter K. Wilson, Jr., "The Problem of Permafrost," *TME*, Vol 40, No 270, April 1948, 162-163.

136 David Neufeld, "Implementing Parks Canada's Cultural Resource Management Policy, Commemorating the Cold War in Canada: Considering the DEW Line," *The Public Historian*, Vol 20, No 1, Winter 1998, 9-19; Rufus D. Crockett, "Oral History Interview," Interviewed by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, April 2005, 8.

137 Alfred Goldberg, ed., *A History of the United States Air Force 1907-1957*, D. Van Nostrand Company, Inc., Princeton, New Jersey, 1957, reprint, Arno Press, Inc., New York, 1974, 193; Col. B. Bagnall, "Building the Distant Early Warning Line," *TME,* Vol 47, No 320 , November-December 1955, 429.

138 Col. B. Bagnall, "Building the Distant Early Warning Line," *TME,* Vol 47, No 320, November-December 1955, 429; Mandy Wharton, "The Cultural Significance of the U.S. Air Force Defensive Radar System," paper for session at WAC4, Jan 1999.

139 David Neufeld, "Implementing Parks Canada's Cultural Resource Management Policy, Commemorating the Cold War in Canada: Considering the DEW Line," *The Public Historian*, Vol 20, No 1, Winter 1998, 9-19.

140 Col. B. Bagnall, "Building the Distant Early Warning Line," *TME,* Vol 47, No 320, November-December 1955, 429; Mandy Wharton, "The Cultural Significance of the U.S. Air Force Defensive Radar System," paper for session at WAC4, Jan 1999.

141 Col. B. Bagnall, "Building the Distant Early Warning Line," *TME,* Vol 47, No 320, November-December 1955, 430; Assistant Chief of Staff, Installations History, January-June 1955, n.p., AHO.

142 Directorate of Installations History, July-December 1957, January-June 1958, n.p., AHO; Boyne, "The Rise of Air Defense," *Air Force Magazine*, December 1999

143 Assistant Chief of Staff, Installations History, July-December 1954, n.p., AHO; Walter Boyne, "The Rise of Air Defense," *Air Force Magazine*, December 1999. The Collins-Vandenberg Agreement, signed on 1 Aug 1950, established cooperation between Air Defense Command and the Army Anti-Aircraft Command for the air defense of the U.S.

144 Harold B. Goyette, "DEW Line Canada-Iceland Link," *TME*, Vol 54, No 361, September-October 1962, 325-328.

145 Harold B. Goyette, "DEW Line Canada-Iceland Link," *TME*, Vol 54, No 361, September-October 1962, 325-328; E. H. Vaughn, Jr., "Construction Planning for Greenland," *TME*, Vol 53, No 353, May-June 1961, 206-208; Gene Augustine, 611th CES Natural Resources Program Manager, to Lois Walker, Email, 16 Oct 2001.

146 E. H. Vaughn, Jr., "Construction Planning for Greenland," *TME*, Vol 53, No 353, May-June 1961, 206-208; Harold B. Goyette, "DEW Line Canada-Iceland Link," *TME*, Vol 54, No 361, September-October 1962, 325; Directorate of Installations History, July-December 1957, n.p., AHO.

147 Harold B. Goyette, "DEW Line Canada-Iceland Link," *TME*, Vol 54, No 361, September-October 1962, 327.

148 Assistant Chief of Staff, Installations History, January-June 1954, AFIR section, AHO; F. F. Newburg, "Tilt-Up Construction Project," *TME*, Vol 46 No 311, May-June 1954, pp 191-193.

149 Harold B. Goyette, "DEW Line Canada-Iceland Link," *TME*, Vol 54, No 361, September-October 1962, 326.

150 Ibid.

151 Ibid.

152 Directorate of Installations History, January-June 1958, n.p., AHO; Harold B. Goyette, "DEW Line Canada-Iceland Link," *TME*, Vol 54, No 361, September-October 1962, 326; H. Vaughn, Jr., "Construction Planning for Greenland," *TME*, Vol 53, No 353, May-June 1961, 206-208.

153 H. Vaughn, Jr., "Construction Planning for Greenland," *TME*, Vol 53, No 353, May-June 1961, 206-208; Directorate of Installations History, July-December 1959, n.p., AHO.

154 Directorate of Installations History, July-December 1959, n.p., AHO; Harold B. Goyette, "DEW Line Canada-Iceland Link," *TME*, Vol 54, No 361, September-October 1962, 326.

155 Assistant Chief of Staff, Installations History, January-June 1954, n.p.; Col. George F. Tait, "Texas Towers," *TME*, Vol 47, No 320, November-December 1955, 436-439.

156 Thomas W. Ray, "A History of Texas Towers in Air Defense, 1952-1964," ADC History Office, March 1965.

157 Ibid.

158 Thomas W. Ray, "A History of Texas Towers in Air Defense, 1952-1964," ADC History Office, March 1965; Col. George F. Tait, "Texas Towers," *TME*, Vol 47, No 320, November-December 1955, 437.

159 Col. George F. Tait, "Texas Towers," *TME*, Vol 47, No 320, November-December 1955, 437.

160 Assistant Chief of Staff, Installations History, July-December 1954, July-December 1955, n.p. AHO; Thomas W. Ray, "A History of Texas Towers in Air Defense, 1952-1964," ADC History Office, March 1965.

161 Thomas W. Ray, "A History of Texas Towers in Air Defense, 1952-1964," ADC History Office, March 1965.

162 Ibid.

163 Directorate of Installations History, January-June 1958, July-December 1958, n.p., AHO; Col. Stanley W. Dzuiban, "Bases for Deterrence," *TME*, Vol 52, No 349, September-October 1960, 375-376.

164 Directorate of Installations History, January-June 1958, n.p. AHO; P.N. Rova, "AF Ballistic Missile Early Warning Construction," *Civil Engineering Beacon*, Vol 6, No 57, February-March 1959, 13; Mandy Wharton, "The Cultural Significance of the U.S. Air Force Defensive Radar System," paper for session at WAC4, Jan 1999.

165 Maj. Gen. E. C. Itschner, "Missile Construction for Security," *TME*, Vol 51, No 342, July-August 1959, p 262; Col. Stanley W. Dzuiban, "Bases for Deterrence," *TME*, Vol 52, No 349, September-October 1960, 375-376.

166 P.N. Rova, "AF Ballistic Missile Early Warning Construction," *Civil Engineering Beacon*, February-March 1959, 13.

167 Brig. Gen. John D. Peters (USAF, Retired), "Oral History Interview," Interviewed by Lois E. Walker and Dr. Ronald B. Hartzer, HQ AFCESA, Tyndall AFB, Florida, June 2001; Brig. Gen. Sheldon J. Lustig (USAF, Retired), "Oral History Interview," Interviewed by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, November 2004; Maj. Gen. Clifton D. Wright (USAF, Retired), "Oral History Interview," Interviewed by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, AFCESA History Office, 2002.

168 John C. Lonnquest and David Winkler, *To Defend and Deter: The Legacy of the United States Cold War Missile Program*, United States Army Construction Engineering Research Laboratories, Champaign, Illinois, 1996, 39; Brig. Gen. William Leonhard, (USAF, Retired), "Interview of Brigadier General William Leonhard, USAF (retired)," Interviewed by Dr. John Lonnquest, U.S. Army Corps of Engineers Office of History, 2000-2001, 29-30.

169 Brig. Gen. William Leonhard, (USAF, Retired), "Interview of Brigadier General William Leonhard, USAF (retired)," Interviewed by Dr. John Lonnquest, U.S. Army Corps of Engineers Office of History, 2000-2001, 29-30.

170 Ibid. 32-33.

171 Ibid. 35.

172 John C. Lonnquest and David Winkler, *To Defend and Deter: The Legacy of the United States Cold War Missile Program*, United States Army Construction Engineering Research Laboratories, Champaign, Illinois, 1996, 39.

173 John C. Lonnquest and David Winkler, *To Defend and Deter: The Legacy of the United States Cold War Missile Program*, United States Army Construction Engineering Research Laboratories, Champaign, Illinois, 1996, 3; Donald R. Baucom, "Eisenhower and Ballistic Missile Defense, the Formative Years, 1944-1961," *Air Power History*, Winter 2004, 6-17.

174 John M. Norvell, "Base Construction for Bomarc," *TME*, Vol 63, No 352, March-April 1961, 129-130; Directorate of Installations History, January-December 1956, n.p., AHO.

175 Robert L. Cotterman, "BOMARC. ADC's Silent Sentry," *Air Force Civil Engineer*, Vol 2, No 2, May 1961, 16.

176 John C. Lonnquest and David Winkler, *To Defend and Deter: The Legacy of the United States Cold War Missile Program*, United States Army Construction Engineering Research Laboratories, Champaign, Illinois, 1996, 3; John M. Norvell, "Base Construction for Bomarc," *TME*, Vol 53, No 352, March-April 1961, 130; Directorate of Installations History, January-June 1958, n.p., AHO.

177 Robert L. Cotterman, "BOMARC. ADC's Silent Sentry," *Air Force Civil Engineer*, Vol 2, No 2, May 1961, 16-17.

178 Ibid. 17-18.

179 Robert L. Cotterman, "BOMARC. ADC's Silent Sentry," *Air Force Civil Engineer*, Vol 2, No 2, May 1961, 18.; Richard B. Hinckley, "Cleanliness . . . a state of mind," *Air Force Civil Engineer*, Vol 2, No 2, May 1961, 8-11.

180 "BOMARC Base," *TME*, Vol 51, No 344, November-December 1959, 499.

181 Robert L. Cotterman, "BOMARC. ADC's Silent Sentry," *Air Force Civil Engineer*, Vol 2, No 2, May 1961, 19, Directorate of Civil Engineering History, January-December 1959, n.p., AHO.

182 Robert L. Cotterman, "BOMARC. ADC's Silent Sentry," *Air Force Civil Engineer*, Vol 2, No 2, May 1961, 19.

183 John T. Correll, "How the Air Force Got the ICBM," *Air Force Magazine*, July 2005, 69-74.

184 John C. Lonnquest and David Winkler, *To Defend and Deter: The Legacy of the United States Cold War Missile Program*, United States Army Construction Engineering Research Laboratories, Champaign, Illinois, 1996, 41; "Early Developments," Federation of American Scientists, accessed December 2011, http://www.fas.org/nuke/guide/usa/icbm/early.htm.

185 John C. Lonnquest and David Winkler, *To Defend and Deter: The Legacy of the United States Cold War Missile Program*, United States Army Construction Engineering Research Laboratories, Champaign, Illinois, 1996, 326; Col. Paul D. Troxler, "Space Missile Facilities," *TME*, Vol 53, No 352, March-April 1961, 104; Brig. Gen. William Leonhard, (USAF, Retired), "Interview of Brig. Gen. William Leonhard, (USAF, Retired)," Interviewed by Dr. John Lonnquest, U.S. Army Corps of Engineers Office of History, 2000-2001.

186 Col. Paul D. Troxler, "Space Missile Facilities," *TME*, Vol 53, No 352, March-April 1961, 104.

187 Directorate of Installations History, July-December 1955, n.p., AHO; Col. Paul D. Troxler, "Space Missile Facilities," *TME*, Vol 53, No 352, March-April 1961, 104.

188 John C. Lonnquest and David Winkler, *To Defend and Deter: The Legacy of the United States Cold War Missile Program*, United States Army Construction Engineering Research Laboratories, Champaign, Illinois, 1996, 326; Col. Paul D. Troxler, "Space Missile Facilities," *TME*, Vol 53, No 352, March-April 1961, 104; Brig. Gen. William Leonhard, (USAF, Retired), "Interview of Brig. Gen. William Leonhard, (USAF, Retired)," Interviewed by Dr. John Lonnquest, U.S. Army Corps of Engineers Office of History, 2000-2001.

189 Col. Paul D. Troxler, "Space Missile Facilities," *TME*, Vol 53, No 352, March-April 1961, 105.

190 Directorate of Installations Histories, January-June 1954; July-December 1956, n.p., AHO.

191 John C. Lonnquest and David Winkler, *To Defend and Deter: The Legacy of the United States Cold War Missile Program*, United States Army Construction Engineering Research Laboratories, Champaign, Illinois, 1996, 313-314.

192 Maj. Gen. Clifton D. Wright (USAF, Retired), "Oral History Interview," Interviewed by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, AFCESA History Office, 2002, 11-14.

193 Ibid.

194 John C. Lonnquest and David Winkler, *To Defend and Deter: The Legacy of the United States Cold War Missile Program*, United States Army Construction Engineering Research Laboratories, Champaign, Illinois, 1996, 314.

195 Maj. Gen. Clifton D. Wright (USAF, Retired), "Oral History Interview," Interviewed by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, AFCESA History Office, 2002, 14-15; Maj. Gen. Joseph A. Ahearn (USAF, Retired), "Oral History Interview," Interviewed by Dr. Douglas M. Merkle and Mrs. Lois E. Walker, September 2007, 11-15.

196 Maj. Gen. Clifton D. Wright (USAF, Retired), "Oral History Interview," Interviewed by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, AFCESA History Office, 2002, 14-15.

197 Brig. Gen. John D. Peters (USAF, Retired), "Oral History Interview," Interviewed by Lois E. Walker and Dr. Ronald B. Hartzer, HQ AFCESA, Tyndall AFB, Florida, June 2001, 21-22.

198 Correll, "How the Air Force Got the ICBM," *Air Force Magazine*, July 2005, 69-74; John C. Lonnquest and David Winkler, *To Defend and Deter: The Legacy of the United States Cold War Missile Program*, United States Army Construction Engineering Research Laboratories, Champaign, Illinois, 1996, 314; Brig. Gen. T. J. Hayes III, "ICBM Site Construction," *TME*, Vol 54, No 362, November-December 1962, 399-403.

199 Robinette E. McCabe, "Largest Rocket Test Stand," *TME*, Vol 51, No 339, January-February 1959, 9-11.

200 John C. Lonnquest and David Winkler, *To Defend and Deter: The Legacy of the United States Cold War Missile Program*, United States Army Construction Engineering Research Laboratories, Champaign, Illinois, 1996, 48; Alfred Goldberg, ed., *A History of the United States Air Force 1907-1957*, D. Van Nostrand Company, Inc., Princeton, New Jersey, 1957, reprint, Arno Press, Inc., New York, 1974, 202.

201 Directorate of Installations History, January-June 1959, n.p., AHO; Oral history interview, Brig. Gen. Sheldon J. Lustig (USAF, Retired), "Oral History Interview," Interviewed by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, November 2004, 27-28.

202 Directorate of Installations History, January-June 1959, n.p., AHO; "Thor Missile Deployment in the U.K.," Carpetbagger Aviation Museum, accessed December 2011, http://harringtonmuseum.org.uk/ThorUK.htm.

203 "Thor Missile Deployment in the U.K.," Carpetbagger Aviation Museum, accessed December 2011, http://harringtonmuseum.org.uk/ThorUK.htm; "Thor Missile," Strategic-Air-Command.com, accessed December 2011, http://www.strategic-air-command.com/missiles/Thor/Thor_Missile_Home_Page.htm.

204 Ibid.

205 Ibid.

206 "Thor Missile Deployment in the U.K.," Carpetbagger Aviation Museum, accessed December 2011, http://harringtonmuseum.org.uk/ThorUK.htm; "Thor Missile," Strategic-Air-Command.com, accessed December 2011, http://www.strategic-air-command.com/missiles/Thor/Thor_Missile_Home_Page.htm; Brig. Gen. Sheldon J. Lustig (USAF, Retired), "Oral History Interview," Interviewed by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, November 2004, 26-34; John C. Lonnquest and David Winkler, *To Defend and Deter: The Legacy of the United States Cold War Missile Program*, United States Army Construction Engineering Research Laboratories, Champaign, Illinois, 1996, 52.

207 Donald R. Baucom, "Eisenhower and Ballistic Missile Defense, the Formative Years, 1944-1961," *Air Power History*, Winter 2004, 10; "Early Developments," Federation of American Scientists, accessed December 2011, http://www.fas.org/nuke/guide/usa/icbm/early.htm.

208 Mark Cleary, "Remembering the Titans," *Missileer* (Patrick AFB newspaper), 27 Apr 07, 9.

209 John C. Lonnquest and David Winkler, *To Defend and Deter: The Legacy of the United States Cold War Missile Program*, United States Army Construction Engineering Research Laboratories, Champaign, Illinois, 1996, 44; Dr. Ronald B. Hartzer, "The Civil Engineer as Partner: ICBM Facility Construction," *Air Force Civil Engineer*, Vol 2, No 6, September-October 1994, 2-3; Col. Stanley W. Dzuiban, "Bases for Deterrence," *TME*, Vol 52, No 349, September-October 1960, 375-376.

210 John C. Lonnquest and David Winkler, *To Defend and Deter: The Legacy of the United States Cold War Missile Program*, United States Army Construction Engineering Research Laboratories, Champaign, Illinois, 1996, 79; Col. Stanley W. Dzuiban, "Bases for Deterrence," *TME*, Vol 52, No 349, September-October 1960, 375-376.

211 John C. Lonnquest and David Winkler, *To Defend and Deter: The Legacy of the United States Cold War Missile Program*, United States Army Construction Engineering Research Laboratories, Champaign, Illinois, 1996, 68-69; Hayes, 399-403; John T. Correll, "How the Air Force Got the ICBM," *Air Force Magazine*, July 2005, 69-74.

212 John T. Correll, "How the Air Force Got the ICBM," *Air Force Magazine*, July 2005, 69-74; Fred Hamlin, "Can Air Force Bases Stay in Step?" *Armed Forces Management*, November 1958, 14; John C. Lonnquest and David Winkler, *To Defend and Deter: The Legacy of the United States Cold War Missile Program*, United States Army Construction Engineering Research Laboratories, Champaign, Illinois, 1996, 85; Brig. Gen. Sheldon J. Lustig (USAF, Retired), "Oral History Interview," Interviewed by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, November 2004. 40-41; Dr. Ronald B. Hartzer, "The Civil Engineer as Partner: ICBM Facility Construction," *Air Force Civil Engineer*, Vol 2, No 6, September-October 1994, 2-3.

213 Dr. Ronald B. Hartzer, "The Civil Engineer as Partner: ICBM Facility Construction," *Air Force Civil Engineer*, Vol 2, No 6, September-October 1994, 2.

214 "Finding Tract Homes for Air Force Ballistic Missiles," *Air Force Civil Engineer*, Vol 2, No 1, February 1961, 4-5.

215 Finding Tract Homes for Air Force Ballistic Missiles," *Air Force Civil Engineer*, Vol 2, No 1, February 1961, 6; Directorate of Installations History, January-June 1958, n.p., AHO.

216 John C. Lonnquest and David Winkler, *To Defend and Deter: The Legacy of the United States Cold War Missile Program*, United States Army Construction Engineering Research Laboratories, Champaign, Illinois, 1996, 440.

217 John C. Lonnquest and David Winkler, *To Defend and Deter: The Legacy of the United States Cold War Missile Program*, United States Army Construction Engineering Research Laboratories, Champaign, Illinois, 1996, 440-441; Directorate of Installations History, January-June 1959, n.p., AHO.

218 John C. Lonnquest and David Winkler, *To Defend and Deter: The Legacy of the United States Cold War Missile Program*, United States Army Construction Engineering Research Laboratories, Champaign, Illinois, 1996, 374.

219 Dr. Ronald B. Hartzer, "The Civil Engineer as Partner: ICBM Facility Construction," *Air Force Civil*

Engineer, Vol 2, No 6, September-October 1994, 3.

220 1st Lt. Ernest D. Strait and D. T. Gunderson, "Canopy for the Atlas," *Air Force Civil Engineer*, Vol 2, No 2, May 1961, 4-6.

221 John C. Lonnquest and David Winkler, *To Defend and Deter: The Legacy of the United States Cold War Missile Program*, United States Army Construction Engineering Research Laboratories, Champaign, Illinois, 1996, 70-71; Brig. Gen. T. J. Hayes III, "ICBM Site Construction," *TME*, Vol 54, No 362, November-December 1962, 401-402.

222 John C. Lonnquest and David Winkler, *To Defend and Deter: The Legacy of the United States Cold War Missile Program*, United States Army Construction Engineering Research Laboratories, Champaign, Illinois, 1996, 322; John T. Correll, "How the Air Force Got the ICBM," *Air Force Magazine*, July 2005, 69-74.

223 Directorate of Civil Engineering Histories, July-December 1959, July-December 1960, n.p., AHO.

224 John C. Lonnquest and David Winkler, *To Defend and Deter: The Legacy of the United States Cold War Missile Program*, United States Army Construction Engineering Research Laboratories, Champaign, Illinois, 1996, 71-72.

225 John C. Lonnquest and David Winkler, *To Defend and Deter: The Legacy of the United States Cold War Missile Program*, United States Army Construction Engineering Research Laboratories, Champaign, Illinois, 1996, 73; Directorate of Installations History, July-December 1958, n.p., AHO.

226 John C. Lonnquest and David Winkler, *To Defend and Deter: The Legacy of the United States Cold War Missile Program*, United States Army Construction Engineering Research Laboratories, Champaign, Illinois, 1996, 73; Directorate of Installations History, January-June 1959, n.p. AHO; John T. Correll, "How the Air Force Got the ICBM," *Air Force Magazine*, July 2005, 69-74.

227 John C. Lonnquest and David Winkler, *To Defend and Deter: The Legacy of the United States Cold War Missile Program*, United States Army Construction Engineering Research Laboratories, Champaign, Illinois, 1996, 366; Directorate of Civil Engineering History, July-December 1959, n.p., AHO.

228 John C. Lonnquest and David Winkler, *To Defend and Deter: The Legacy of the United States Cold War Missile Program*, United States Army Construction Engineering Research Laboratories, Champaign, Illinois, 1996, 4-6.

229 Assistant Chief of Staff, Installations History, January-June 1954, n.p., AHO.

230 Lawrence C. Landis, *The Story of the U.S. Air Force Academy*, New York. Rinehart & Company, Inc., 1960, 54-55.

231 Dr. Ronald B. Hartzer, "Building an Institution: The Construction of the U.S. Air Force Academy," *U.S. Air Force Civil Engineer*, Vol 2, No 5, July-August 1994, 15-17; Directorate of Installations History, July 1949-June 1950, n.p., AHO.

232 Lawrence C. Landis, *The Story of the U.S. Air Force Academy*, New York. Rinehart & Company, Inc., 1960, 59-61.

233 HQ Command General Order 32, 4 June 1954; Assistant Chief of Staff, Installations History, January-June 1954, AHO; "Meet Col. James A. Barnett, PE," *Air Force Civil Engineer*, Vol 8, No 2, May 1967, 7; *Installations Engineer Beacon*, Vol 9, November 1954, 5.

234 Dr. Ronald B. Hartzer, "Building an Institution: The Construction of the U.S. Air Force Academy," *U.S. Air Force Civil Engineer*, Vol 2, No 5, July-August 1994, 15-17; Assistant Chief of Staff, Installations History, January-June 1954; Assistant Chief of Staff, Installations History, January-June 1955, n.p., AHO.

235 Assistant Chief of Staff, Installations History, January-June 1954, n.p., AHO.

236 Assistant Chief of Staff, Installations History, January-June 1954, n.p., AHO; Dr. Ronald B. Hartzer, "Building an Institution: The Construction of the U.S. Air Force Academy," *U.S. Air Force Civil Engineer*, Vol 2, No 5, July-August 1994, 15-17.

237 Col. Albert E. Stoltz, "Plans for the United States Air Force Academy," *TME*, Vol 48, No 326, November-December 1956, 446-447; Assistant Chief of Staff, Installations History, January-June 1955; *Installations Engineer Beacon*, Vol 16, June 1955, 2.

238 Robert Bruegmann, ed., *Modernism at Mid-Century. The Architecture of the United States Air Force Academy,* Chicago. University of Chicago Press, 1994.

239 Assistant Chief of Staff, Installations History, January-June 1955, n.p., AHO; Assistant Chief of Staff, Installations History July-December 1955, n.p., AHO.

240 Assistant Chief of Staff, Installations History, July-December 1954, January-June 1955, n.p., AHO; Lawrence C. Landis, *The Story of the U.S. Air Force Academy*, New York. Rinehart & Company, Inc., 1960, 69.

241 Dr. Ronald B. Hartzer, "Building an Institution: The Construction of the U.S. Air Force Academy," *U.S. Air Force Civil Engineer*, Vol 2, No 5, July-August 1994, 15-17; Assistant Chief of Staff, Installations History, January-June 1955, n.p., AHO.

242 Assistant Chief of Staff, Installations History, July-December 1955, n.p., AHO.

243 Assistant Chief of Staff, Installations History, January-June 1956, n.p., AHO; Directorate of Installations History, January-June 1958; July-December 1958; January-June 1959, n.p., AHO.

244 Assistant Chief of Staff, Installations History, January-June 1956; January-June 1957, n.p., AHO.

245 Dr. Ronald B. Hartzer, "Building an Institution: The Construction of the U.S. Air Force Academy," *U.S. Air Force Civil Engineer*, Vol 2, No 5, July-August 1994, 15-17; Assistant Chief of Staff, Installations History, July-December 1955; Duane Boyle, USAFA/CEPD to Lois Walker, Email, 22 Aug 07, AHO.

246 Lawrence C. Landis, *The Story of the U.S. Air Force Academy*, New York. Rinehart & Company, Inc., 1960, 68-69; Assistant Chief of Staff, Installations History, January-June 1957; Directorate of Installations History, July-December 1958, n.p., AHO.

247 Directorate of Installations History, July-December 1957, n.p., AHO.

248 Ibid.

249 Assistant Chief of Staff, Installations, History, January-June 1957, n.p., AHO.

250 Dr. Ronald B. Hartzer, "Building an Institution: The Construction of the U.S. Air Force Academy," *U.S. Air Force Civil Engineer*, Vol 2, No 5, July-August 1994, 15-17; Assistant Chief of Staff, Installations History, January-June 1957, n.p., AHO; U.S. Air Force Biographies: Lt. Gen. Hubert R. Harmon and Maj. Gen. James E. Briggs, U.S. Air Force, accessed various dates, www.af.mil/information/bios.

251 Dr. Ronald B. Hartzer, "Building an Institution: The Construction of the U.S. Air Force Academy," *U.S. Air Force Civil Engineer*, Vol 2, No 5, July-August 1994, 15-17; Directorate of Installations History, July-December 1957, n.p., AHO.

252 Assistant Chief of Staff, Installations History, January-July 1956, January-June 1957, AHO; Directorate of Installations History, January-June 1958, July-December 1958, n.p., AHO.

253 Air Force General Order 20, 23 April 1958; USAFA General Order 13, 30 June 1958; Directorate of Installations History, January-June 1958, n.p., AHO.

254 Directorate of Installations History, July-December 1958; January-June 1959, n.p., AHO.

255 Directorate of Installations History, July-December 1958, n.p., AHO.

256 Directorate of Installations History, July-December 1959, n.p., AHO; Dr. Ronald B. Hartzer, "Building an Institution: The Construction of the U.S. Air Force Academy," *U.S. Air Force Civil Engineer*, Vol 2, No 5, July-August 1994, 15-17.

257 See note above.

258 Dr. Ronald B. Hartzer, "Building an Institution: The Construction of the U.S. Air Force Academy," *U.S. Air Force Civil Engineer*, Vol 2, No 5, July-August 1994, 15-17; Directorate of Installations History, January-June 1959, n.p., AHO.

259 Dr. Ronald B. Hartzer, "Building an Institution: The Construction of the U.S. Air Force Academy," *U.S. Air Force Civil Engineer*, Vol 2, No 5, July-August 1994, 15-17.

260 Directorate of Installations History, July-December 1952; January-June 1954, n.p., AHO.

261 Alfred Goldberg, ed., *A History of the United States Air Force 1907-1957*, D. Van Nostrand Company, Inc., Princeton, New Jersey, 1957, reprint, Arno Press, Inc., New York, 1974, 147-149, 124-125; Frederick J. Shaw, ed., *Locating Air Force Base Sites, History's Legacy,* Air Force History and Museum Program, Washington, D.C., 2004, 60.

262 Col. Robert H. Curtin, "Air Force Construction, Its Organization and Planning," Thesis, Air War College, Air University, Maxwell AFB, Alabama, 1954, 109; Alfred Goldberg, ed., *A History of the United States Air Force 1907-1957*, D. Van Nostrand Company, Inc., Princeton, New Jersey, 1957, reprint, Arno Press, Inc., New York, 1974, 191-193; Directorate of Installations History, July-December 1952; January-June 1953, n.p., AHO.

263 Robert P. Grathwol and Donita M. Moorhus, *Building for Peace: U.S. Army Engineers in Europe, 1945 – 1991,* U.S. Army Corps of Engineers, Center of Military History, United States Army 2005, 101.

264 Ibid. 102.

265 David H. Tulley, "The Military Construction Program," *TME*, Vol 46, No 314, November-December 1954, 408.

266 Robert P. Grathwol and Donita M. Moorhus, *Building for Peace: U.S. Army Engineers in Europe, 1945 – 1991,* U.S. Army Corps of Engineers, Center of Military History, United States Army 2005, 102-104.

267 Brig. Gen. John D. Peters (USAF, Retired), "Oral History Interview," Interviewed by Lois E. Walker and Dr. Ronald B. Hartzer, HQ AFCESA, Tyndall AFB, Florida, June 2001, 16-17.

268 Robert P. Grathwol and Donita M. Moorhus, *Building for Peace: U.S. Army Engineers in Europe, 1945 – 1991,* U.S. Army Corps of Engineers, Center of Military History, United States Army 2005, 115-116.

269 W.K. Wilson, Jr. "Overseas Military Construction," *TME*, Vol 50, No 337, September-October 1958, 330.

270 Lt. Col. Bernard Card, "The Role of Engineers in the Air Force," Research report, Air War College, Maxwell AFB, Alabama, 1948, 61-62; Capt. L. Dean Waggoner and 1st Lt. M. Allen Moe, "A History of Air Force Civil Engineering Wartime and Contingency Problems from 1941 to the Present," Thesis, Air University, AFIT, WPAFB, Ohio, 1985, 117.

271 "Pigskin Parable," *Air Force Civil Engineer*, Vol 1, No 2, May 1960, 3-4; Maj. Gen. Lee B. Washbourne, "Installations Engineer Career Field of the Air Force," *Journal*, Washington, D.C., 31 October 1953; Col. Joel Yates, "Growth of UASF Physical Plant," *Civil Engineer Beacon*, Vol 6, No 60, August-October 1959, 8-9.

272 Maj. Gen. Lee B. Washbourne, "Installations Engineer Career Field of the Air Force," *Journal*, Washington, D.C., 31 October 1953.

273 Army Air Forces Regulation 20-42, *Buildings and Grounds Post Engineer*, 13 July 1944, 18 July 1944; Dr. Ronald B. Hartzer, "History Lesson: What's In a Name?," *The U.S. Air Force Civil Engineer*, Vol 2, No 2, March 1994, 2-3.

274 Army Air Forces Regulation 20-42, *Organization Post Engineer*, 20 February 1945.

275 Dr. Ronald B. Hartzer, "History Lesson: What's In a Name?," *The U.S. Air Force Civil Engineer*, Vol 2, No 2, March 1994, 2-3; Army Air Forces Regulation 20-42, 3 January 1947.

276 Air Force Regulation 20-42, *Air Installation Officer*, 6 February 1948, 1.

277 Ibid.

278 Continental Air Command, "Air Installations," Manual 50-10, Vol 1, January 1952, 14-15.

279 *Installations Engineer Beacon*, Vol 7, November 1954, n.p.; *Installations Engineer Beacon*, Vol 26, April 1956, 2.

280 Air Force Regulation 20-42A, *Installations Engineer Management and Organization Program*, 24 October 1956, 3 September 1957.

281 Air Force Regulation 20-42, *Air Installation Officer*, 6 February 1948, 1.

282 Ibid., 1; Air Installations, Vol 1, Continental Air Command Manual 50-10, January 1952, 1.

283 "Air Force Engineer Staff," *TME,* Vol 40, No 276, October 1948, 473; "Air Installation Officers Needed," *TME*, Vol 41, No 280, March-April 1949, 124.

284 Col. Edwin M. Eads, "The Air Force Installations Representatives," *TME*, Vol 48, No 325, September-October 1956, 362-363; Maj. Gen. Lee B. Washbourne, "Installations Engineer Career Field of the Air Force," *Journal*, Washington, D.C., 31 October 1953.

285 "Air Force Installations Officers," *TME*, Vol 47, No 315, January-February 1955, 59.

286 Brig. Gen. John D. Peters (USAF, Retired), "Oral History Interview," Interviewed by Lois E. Walker and Dr. Ronald B. Hartzer, HQ AFCESA, Tyndall AFB, Florida, June 2001, iii-v.

287 Ibid. v.

288 Ibid.

289 Air Force Regulation 20-42, *Installations Engineer Management and Organization Program*, 24 October 1956, 1-6.

290 Air Force Regulation 20-42, *Air Installation Officer*, 6 February 1948; Air Installations, Vol 1, Continental Air Command Manual 50-10, January 1952, 10-11.

291 Air Force Regulation 20-42, *Installations Engineer Management and Organization Program*, 24 October 1956, 3, 12.

292 Air Staff History, January-June 1951, AHO; Air Force Regulation 85-5, *Maintenance of Installations*, 30 June 1951.

293 Brig. Gen. John D. Peters (USAF, Retired), "Oral History Interview," Interviewed by Lois E. Walker and Dr. Ronald B. Hartzer, HQ AFCESA, Tyndall AFB, Florida, June 2001, 12.

294 Brig. Gen. Archie S. Mayes (USAF, Retired), "Oral History Interview," Interviewed by Lois E. Walker, AFCESA HQ, Tyndall, AFB, Florida, 2000, ii-iv.

295 Ibid. v, 36-38, 41.

296 Assistant Chief of Staff, Installations History, July-December 1955, AHO.

297 *Installations Engineer Beacon*, Vol 22, December 1955, 8; *Installations Engineer Beacon*, Vol 20, October 1955, 7.

298 Air Force Regulation 85-5, *Maintenance of Installations*, 30 June 1951; Air Force Regulation 20-42, *Installations Engineer Management and Organization Program*, 24 October 1956.

299 Air Force Regulation 20-42, *Installations Engineer Management and Organization Program*, 24 October 1956, 2.

300 Directorate of Installations History, January-June 1958, n.p., AHO; *Installations Engineer Beacon* Vol 17, July 1955, 7

301 Directorate of Installations History, July-December 1959, n.p., AHO.

302 Col. Robert H. Curtin, "Air Force Construction, Its Organization and Planning," Thesis, Air War College, Air University, Maxwell AFB, Alabama, 1954, 37-40, 61-62.

303 Directorate of Installations History, July 1949-June 1950, n.p., AHO.

304 Directorate of Installations History, July 1949-June 1950, n.p., AHO; Directorate of Installations History, July-December 1950, n.p., AHO.

305 Brig. Gen. William T. Meredith, (USAF, Retired), "Oral History Interview," Interviewed by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, December 2001, 53.

306 Directorate of Installations History, July-December 1951, n.p., Files of AFCESA History Office, Tyndall, AFB, Florida.

307 Col. Robert H. Curtin, "Air Force Construction, Its Organization and Planning," Thesis, Air War College, Air University, Maxwell AFB, Alabama, 1954, 129-130.

308 Assistant Chief of Staff, Installations History, January-June 1954, n.p., AHO.

309 Assistant Chief of Staff, Installations History, July-December 1954, n.p., AHO.

310 Brig. Gen. Archie S. Mayes (USAF, Retired), "Oral History Interview," Interviewed by Lois E. Walker, AFCESA HQ, Tyndall, AFB, Florida, 2000, 42.

311 Army Air Forces Regulation 20-42, Post Engineer, 18 July 1944, 1.

312 Lt. Col. Bernard Card, "The Role of Engineers in the Air Force," Research report, Air War College, Maxwell AFB, Alabama, 1948, 69; "Langley Fire Department Maintains Splendid Record," *The Tailspinner*, Langley Field, Virginia, 16 June 1944, 5.

313 Continental Air Command, *Air Installations, Volume II*, May 1949, 247.

314 "Langley Fire Department Maintains Splendid Record," *The Tailspinner*, Langley Field, Virginia, 16 June 1944, 5.

315 Douglas E. Courchene, *Pioneers with Intent, Memoirs of an Air Force Fire Fighter*, Air Force Civil Engineer Support Agency, Tyndall AFB July 2003, 45, 43, 69.

316 Air Force Regulation 20-42, Air Installation Officer, 3 January 1947, 1.

317 Air Force Regulation 20-42, Air Installation Officer, 6 February 1948; Air Force Regulation 20-42, Installations Engineer Management and Organization Program, 24 October 1956.

318 Continental Air Command, *Air Installations, Volume II*, May 1949, 243, 248.

319 Douglas E. Courchene, *Pioneers with Intent, Memoirs of an Air Force Fire Fighter*, Air Force Civil Engineer Support Agency, Tyndall AFB July 2003, 4-5.

320 *Installations Engineer Beacon*, Vol 13, March 1955, 5.

321 Air Staff History July-December 1949, January-June 1952, January-June 1953, n.p., AHO.

322 *Installations Engineer Beacon*, Vol 19, September 1955, 11; *Installations Engineer Beacon*, Vol 6, No 60, August-October 1959, 9.

323 Air Staff History July-December 1949, January-June 1952, January-June 1953, n.p., AHO.

324 "33d Annual Meeting of The Society," *TME*, Vol 45, No 304, March-April 1953, 87-88.

325 Air Staff History July-December 1951, AHO; Douglas E. Courchene, *Pioneers with Intent, Memoirs of an Air Force Fire Fighter*, Air Force Civil Engineer Support Agency, Tyndall AFB July 2003, 72, 76.

326 Staff History January-June 1952, n.p., AHO; G.Y. Coats, "A History of USAF Fire Protection Training at Chanute AFB 1964-1976," Chanute Technical Training Center, February 1977, n.p.

327 Air Staff History, January-June 1955, n.p., AHO; Douglas E. Courchene, *Pioneers with Intent, Memoirs of an Air Force Fire Fighter*, Air Force Civil Engineer Support Agency, Tyndall AFB July 2003, 33, 39-40.

328 Air Staff History, January-June 1959, n.p., AHO.

329 Capt. Joe G. Ballard, "An Organizational History of Air Force Fire Protection," Thesis, Department of the Air University, AFIT, 1987, 28-29; Douglas E. Courchene, *Pioneers with Intent, Memoirs of an Air Force Fire Fighter*, Air Force Civil Engineer Support Agency, Tyndall AFB July 2003, 33, 78-79.

330 Air Force Regulation 20-42, Air Installation Officer, 6 February 1948; Air Force Regulation 20-42, Installations Engineer Management and Organization Program, 24 October 1956.

331 *Installations Engineer Beacon*, Vol 27, May 1956, 5.

332 Fred Hamlin, "Can Air Force Bases Stay in Step?," *Armed Forces Management*, November 1958, 12-14.

333 Claude F. Browning, "Utility Service Contracts," *Installations Engineer Beacon*, Vol 56, January 1959, 11-12; Maj. Gen. Robert H. Curtin, "Cost Reduction," Air Force Civil Engineer, Vol 5 No 2 May 1964, 1.

334 Directorate of Installations History July-December 1959, n.p., AHO.

335 Air Force Regulation 20-42A, *Installations Engineer Management and Organization Program*, 24 October 1956.

336 *Installations Engineer Beacon*, Vol 37, April 1957, 1-2.

337 *Installations Engineer Beacon*, Vol 52, July 1958, 1-3.

338 Directorate of Installations History, July-December 1951, January-June 1953, n.p., AHO; Assistant Chief of Staff, Installations History, July-December 1954, n.p., AHO.

339 Alfred Goldberg, ed., *A History of the United States Air Force 1907-1957*, D. Van Nostrand Company, Inc., Princeton, New Jersey, 1957, reprint, Arno Press, Inc., New York, 1974, 194-195.

340 Assistant Chief of Staff, Installations History, January-June 1955, n.p., AHO; *Installations Engineer Beacon*, Vol 23, January 1956, 4.

341 "AFIT History," AFIT, accessed December 2008, http://www.afit.edu/about.cfm?a=history; Ashdown, 13.

342 "AFIT History," AFIT, accessed December 2008, http://www.afit.edu/about.cfm?a=history; Ashdown, 13; Eugene E. Peer, *History of the Civil Engineering School, AFIT*, November 1976, 4, AHO.

343 Eugene E. Peer, *History of the Civil Engineering School, AFIT*, November 1976, 5-7, AHO.

344 "USAF Institute of Technology," *Installations Engineer Beacon*, Vol 10, December 1954, 6.

345 Ibid.

346 "AFIT History," AFIT, accessed December 2008, http://www.afit.edu/about.cfm?a=history; Ashdown, 13; Eugene E. Peer, *History of the Civil Engineering School, AFIT*, November 1976, 8-9, AHO; "USAF Institute of Technology," *Installations Engineer Beacon*, Vol 10, December 1954, 6; "Installations Engineering School to Begin New Advanced Course in September," *Installations Engineer Beacon*, Vol 26, April 1956, 1.

347 "AFIT History," AFIT, accessed December 2008, http://www.afit.edu/about.cfm?a=history; Ashdown, 13; Eugene E. Peer, *History of the Civil Engineering School, AFIT*, November 1976, 4, AHO.

348 Lois E. Walker and Shelby E. Wickman, *From Huffman Prairie to the Moon, The History of Wright-Patterson Air Force Base*, United States Air Force Logistics Command, U.S. Government Printing Office, Washington, DC, 1986, 414.

349 Ibid. 414-415.

350 Thomas A. Manning, Dr. Bruce A. Ashcroft, Richard E. Emmons, Ann K. Hussey, and Dr. Joseph L. Mason, *History of Air Education and Training Command 1942-2002*, Office of History and Research Headquarters, Air Education and Training Command, Randolph AFB, Texas, 2005, 47-51, accessed December 2008,

www.aetc.af.mil/shared/media/document/AFD-061109-022.pdf.

351 Ibid. 51-42.

352 Office of History, HQ 82d Training Wing, "A Brief History of Sheppard AFB and the 82d Training Wing," Office of History, HQ 82d Training Wing, Sheppard AFB, Texas, 1 July 2006, 30, accessed January 2011, www.sheppard.af.mil/shared/media/document/AFD-061113-068.pdf.

353 Thomas A. Manning, Dr. Bruce A. Ashcroft, Richard E. Emmons, Ann K. Hussey, and Dr. Joseph L. Mason, *History of Air Education and Training Command 1942-2002*, Office of History and Research Headquarters, Air Education and Training Command, Randolph AFB, Texas, 2005, 48, 61, accessed December 2008, www.aetc.af.mil/shared/media/document/AFD-061109-022.pdf; Lt. Col. George Talbot, PE, "Training for…Civil Engineering Technicians," *Air Force Civil Engineer*, Vol 4, No 4, November 1963, 18; CMSgt. Chuck Perry and STTC Team, "USAF Civil Engineering Training – Leading the Way!," *The U.S. Air Force Civil Engineer*, Vol 1, No 7, September-October 1993, 13; Dr. Ronald B. Hartzer, "Training Experiment: The Aviation Engineer Force," *The U.S. Air Force Civil Engineer*, Vol 1, No 7, September-October 1993, 10-11.

354 Douglas E. Courchene, *Pioneers with Intent, Memoirs of an Air Force Fire Fighter*, Air Force Civil Engineer Support Agency, Tyndall AFB, Florida July 2003, 53- 56.

355 Air Staff History, January-June 1955, n.p., AHO.

356 Ashdown, 10.

357 Brig. Gen. John D. Peters (USAF, Retired), "Oral History Interview," Interviewed by Lois E. Walker and Dr. Ronald B. Hartzer, HQ AFCESA, Tyndall AFB, Florida, June 2001, 10-11.

358 Ashdown, 11.

359 Col. Eric Duggan, "Some Implications of Transferring the Aviation Engineers to the Air Force," Thesis, Air War College, Maxwell AFB, Alabama, April 1954, 15-18.

360 Lt. Col. Benjamin Card, "The Role of Engineers in the Air Force," Thesis, Air War College, Maxwell AFB, Alabama, February 1948, 103.

361 William C. Baldwin, "Engineers and the Berlin Airlift, 1948-1949," *Engineer*, April 1998, 35-37; Daniel F. Harrington, *"The Air Force Can Deliver Anything!" A History of the Berlin Airlift*, USAFE Office of History, May 1998, 1, 30; Maj. Herbert J. Gall, "Flugplatz Tempelhof," *TME*, Vol 42, No 288, July-August 1950, 289-290.

362 Brig. Gen. William Leonhard (USAF, Retired), "Interview of Brig. Gen. William Leonhard (USAF, Retired)," Interviewed by Dr. John Lonnquest, Office of History, U.S. Army Corps of Engineers, 2001, 25, 26, 28, AHO.

363 Directorate of Installations Histories, July 1949-June 1950, January-June 1951, n.p., AHO

364 Directorate of Installations Histories, July 1949-June 1950, January-June 1951; July-December 1951, n.p., AHO

365 Directorate of Installations History, January-June 1951, n.p., AHO.

366 Aviation Engineer Force, "An Analysis of Operational Activities, 1951-1956," 5, AHO.

367 Col. H. R. Hallock, "Troop Operations in the North," *TME*, Vol 48, No 323, May-June 1956, 214-217; Directorate of Installations Histories, July 1949-June 1950 and July-December 1950, n.p., AHO.

368 Robert P. Grathwol and Donita M. Moorhus, *Building for Peace: U.S. Army Engineers in Europe, 1945-1991*, U.S. Army Corps of Engineers Office of History, 2006, 64; Dr. Ronald B. Hartzer, USAFE/HO to Lois Walker, AFCESA/HO, Email, 21 June 02; "SCARWAF Units in Europe," AHO.

369 S.D. Sturgis, Jr., "Air Power as Affected by Airdrome Construction," *TME*, Vol 40, No 274, August 1948, 355-357; S.D. Sturgis, Jr., "Air Power as Affected by Airdrome Construction," *TME*, Vol 40, No 275, September 1948, 416-419.

370 John Lewis Gaddis, *The Cold War. A New History*, The Penguin Press, New York, 2005, 41.

371 Ibid.

372 Robert F. Futrell, The United States Air Force in Korea 1950-1953, Revised Edition, Office of Air Force History, U.S. Air Force, Washington, D.C., 1983, 498.

373 Ashdown, 16-17.

374 Capt. L. Dean Waggoner and 1st Lt. M. Allen Moe, "A History of Air Force Civil Engineering Wartime and Contingency Problems from 1941 to the Present," Thesis, Air University, AFIT, WPAFB, Ohio, 1985, 123; Robert F. Futrell, The United States Air Force in Korea 1950-1953, Revised Edition, Office of Air Force History, U.S. Air Force, Washington, D.C., 1983, 61-62.

375 Ashdown, 17.

376 Don K Tomajan, III, "Aviation Engineer Contributions to the Air War in Korea," *Air Force Civil Engineer*, Vol 9, No 4, Winter 2001, 13-21; Capt. L. Dean Waggoner and 1st Lt. M. Allen Moe, "A History of Air Force Civil Engineering Wartime and Contingency Problems from 1941 to the Present," Thesis, Air University, AFIT, WPAFB, Ohio, 1985, 123.

377 William E. Leonhard, "Use of Civilian Contractors For Air Force Construction," Research Paper, Air War College, Air University, Maxwell AFB, Alabama, 1952, Appendix A.

378 Don K Tomajan, III, "Aviation Engineer Contributions to the Air War in Korea," *Air Force Civil Engineer,* Vol 9, No 4, Winter 2001, 13-21; Ashdown, 17.

379 John G. Westover, *U.S. Army In Action Series; Combat Support in Korea*," Center of Military History, U.S. Army, Washington, D.C.

380 Robert F. Futrell, The United States Air Force in Korea 1950-1953, Revised Edition, Office of Air Force History, U.S. Air Force, Washington, D.C., 1983, 65; Don K. Tomajan III, "Aviation Engineer Contributions to the Air War in Korea, 1950-1953," *Air Force Civil Engineer*, Vol 9 No 4, Winter 2001, 13-21.

381 "Summary History of Engineer Effort in Korea 25 June 1950 – 1 November 1950," 2, AHO; Ashdown, 18.

382 Capt. L. Dean Waggoner and 1st Lt. M. Allen Moe, "A History of Air Force Civil Engineering Wartime and Contingency Problems from 1941 to the Present," Thesis, Air University, AFIT, September 1985, 136.

383 "Air Force Construction in Korea 1950-1953," 1, AHO; Lt. Col. Joseph L. Albert and Capt. Billy C. Wylie, "Air War in Korea: IV Problems of Airfield Construction in Korea," *Air University Quarterly Review,* Vol 5, No 1, Winter 195,189; Capt. L. Dean Waggoner and 1st Lt. M. Allen Moe, "A History of Air Force Civil Engineering Wartime and Contingency Problems from 1941 to the Present," Thesis, Air University, AFIT, September 1985, 136-137.

384 Lt. Col. Mitchell Goldenthal, "K-6 Air Base Construction," *TME*, Vol 46, No 309, January-February 1954, 38.

385 Ashdown, 18-19.

386 Ibid. 20.

387 "Review of Airfield Construction and the Related Problems in the Korean Theater of Operations from 1 July 1950 to 31 May 1951," 5AF Deputy for Installations, 9 Jun 1951, 5-9, AHO; Ashdown, 19.

388 "Review of Airfield Construction and the Related Problems in the Korean Theater of Operations from 1 July 1950 to 31 May 1951," 5AF Deputy for Installations, 9 Jun 1951, 9-10, AHO.

389 Maj. Alfred B. Hicks, Jr., "Statements of Belief Relating to the Combat Employment of Civil Engineering Forces," Student Report, Air Command and Staff College, Maxwell AFB, Alabama, 1986, 40.

390 Ronald B. Hartzer, *From Sandbags to MAAS: Aircraft Arresting Systems,* AHO.

391 H.E. Burchell, "Aircraft Arresting Barriers," *TME*, Vol 59, No 390, July-August 1967,267.

392 History of Directorate of Installations, HQ Fifth Air Force, February 1953, n.p., AHO.

393 H.E. Burchell, "Aircraft Arresting Barriers," *TME*, Vol 59, No 390, July-August 1967,267.

394 James H. White, "Runway Arresting Barriers," *Civil Engineering Beacon*, Vol 6, No 58, April-May 1959, 6.

395 H.E. Burchell, "Aircraft Arresting Barriers," *TME*, Vol 59, No 390, July-August 1967,267.

396 "FEAF Korean War Report: SCARWAF Engineering Aviation Units—Our Chosen Construction Forces," Air Force Historical Research Agency, Maxwell AFB, Alabama, AHO.

397 Ashdown, 15.

398 Ashdown, 29; Capt. L. Dean Waggoner and 1st Lt. M. Allen Moe, "A History of Air Force Civil Engineering Wartime and Contingency Problems from 1941 to the Present," Thesis, Air University, AFIT, September 1985, 150-151.

399 Maj. Leonard B. Reppert, "The Installations Squadron in Korea," *Air University Quarterly Review*, Spring 1952, 87-97; Ashdown, 29; Maj. Alfred B. Hicks, Jr., "Statements of Belief Relating to the Combat Employment of Civil Engineering Forces," Student Report, Air Command and Staff College, Maxwell AFB, Alabama, 1986, 37.

400 "Review of Airfield Construction and the Related Problems in the Korean Theater of Operations from 1 July 1950 to 31 May 1951," 5AF Deputy for Installations, 9 June 1951, 3, AHO.

401 "September 1951 Report," Deputy for Installations, HQ Seoul, Korea, AHO; Capt. L. Dean Waggoner and 1st Lt. M. Allen Moe, "A History of Air Force Civil Engineering Wartime and Contingency Problems from 1941 to the Present," Thesis, Air University, AFIT, WPAFB, Ohio, September 1985, 155.

402 Ashdown, 25

403 Ibid. 25-28.

404 John Lewis Gaddis, *The Cold War. A New History,* The Penguin Press, New York, 2005, 50.

405 Don K. Tomajan, III, "Aviation Engineer Contributions to the Air War in Korea," *Air Force Civil Engineer*, Vol 9, No 4, Winter 2001, 13; Ashdown, 32; "An Analysis of Operational Activities 1951-1956," 7, AHO.

406 Maj. Alfred B. Hicks, Jr., "Statements of Belief Relating to the Combat Employment of Civil Engineering Forces," Student Report, Air Command and Staff College, Maxwell AFB, Alabama, 1986, 42-46.

407 Dr. Ronald B. Hartzer, "Training Experiment: The Aviation Engineer Force," *Air Force Civil Engineer*, Vol 1, No 7, September-October 1993, 10; Col. George A. Bohlen, *USAF Engineer Heavy Repair/Troop Construction Capability*, Research Report No. 9, Maxwell AFB, Alabama: Air War College, May 1977, 1.

408 Dr. Ronald B. Hartzer, "Training Experiment: The Aviation Engineer Force," *Air Force Civil Engineer*, Vol 1, No 7, September-October 1993, 10; Monthly Historical Report, Deputy for Installations, HQ Seoul, Korea, Jul 1951; "Summary History of Engineer Effort in Korea, 25 Jun 50-1 Nov 50," 7.

409 AEF, "An Analysis of Operational Activities," iv, 22; Dr. Ronald B. Hartzer, "Training Experiment: The Aviation Engineer Force," *Air Force Civil Engineer*, Vol 1, No 7, September-October 1993, 10.

410 AEF, "An Analysis of Operational Activities," iv-v, AHO.

411 Ibid.; Brig. Gen. Ehrgott Air Force bio; Brig. Gen. Guy Goddard Air Force bio.

412 "Fort Huachuca Timeline," Fort Huachuca Museum, accessed December 2011, http://www.huachuca.army.mil/sites/history/PDFS/FHTIME.PDF.

413 Dr. Ronald B. Hartzer, "Training Experiment: The Aviation Engineer Force," *Air Force Civil Engineer*, Vol 1, No 7, September-October 1993, 10.

414 AEF, "An Analysis of Operational Activities," 19, AHO.

415 Ibid. 1-2.

416 Dr. Ronald B. Hartzer, "Training Experiment: The Aviation Engineer Force," *Air Force Civil Engineer*, Vol 1, No 7, September-October 1993, 10.

417 AEF, "An Analysis of Operational Activities," 2-3, AHO.

418 Ibid., 11; AFR 50-20, "Aviation Engineer Training," 25 Apr 1950, which superseded Air Force Letter 50-34, 6 Oct 1948.

419 AEF, "An Analysis of Operational Activities," 4-5, AHO.

420 Ibid.; History of the 820th Engineer Aviation Battalion, 1 March 52–25 September 1955, 107-8, AHO.

421 Dr. Ronald B. Hartzer, "Training Experiment: The Aviation Engineer Force," *Air Force Civil Engineer*, Vol 1, No 7, September-October 1993, 10-11.

422 AEF, "An Analysis of Operational Activities," 27-28, AHO.

423 Ibid, 18; Dr. Ronald B. Hartzer, "Training Experiment: The Aviation Engineer Force," *Air Force Civil Engineer*, Vol 1, No 7, September-October 1993, 11.

424 AEF, "An Analysis of Operational Activities," 12, AHO.

425 Ibid. 12-13.

426 Ibid. 9; Dr. Ronald B. Hartzer, "Training Experiment: The Aviation Engineer Force," *Air Force Civil Engineer*, Vol 1, No 7, September-October 1993, 11.

427 "SCARWAF Units in Europe," AHO.

428 Ashdown, 14.

429 Assistant Chief of Staff, Installations History, January-June 1954, AHO.

430 Maj. Gen. Guy H. Goddard, (USAF, Retired), "Oral History Interview," interviewed by Dr. Ronald B. Hartzer and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, February 2003, iv, 6.

431 Assistant Chief of Staff, Installations History, January-June 1955, AHO.

432 Brig. Gen. William T. Meredith, (USAF, Retired), "Oral History Interview," Interviewed by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, December 2001, 42.

433 Reuben B. Robertson, Jr., Memorandum for the Secretary of the Army and the Secretary of the Air Force, Subject: Special Category, Army Units with Air Force (SCARWAF), Washington, D.C., 2 December 1955, AHO.

434 "SCARWAF Units in Europe," AHO.

435 "Military Notes Around the World," *Military Review*, February 1965, 68.

436 Assistant Chief of Staff, Installations History, January-June 1957; Directorate of Installations History, July-December 1957, n.p., AHO.

437 "Military Notes Around the World," *Military Review*, February 1965, 68.

438 "Single Army-Air Force Engineer Service," *TME*, Vol 48, No 321, January-February 1956, 61.

439 Assistant Chief of Staff, Installations History, January-June 1956, AHO.

440 Assistant Chief of Staff, Installations History, July-December 1956, Files of AFCESA History Office, Tyndall AFB, Florida.

441 Capt. L. Dean Waggoner and 1st Lt. M. Allen Moe, "A History of Air Force Civil Engineering Wartime and Contingency Problems from 1941 to the Present," Thesis, Air University, AFIT, WPAFB, Ohio, 1985, 190.

442 David A. Byrd, "Lebanon Crisis: Operation BLUE BAT," Warnock, A. Timothy, Ed., Ed. *Short of War: Major USAF Contingency Operations*, Air Force History and Museums Program, Air University Press, Maxwell AFB, Alabama, 2000, 11-21; Ashdown, 35; Stanley Kachel, "Lebanon 1958, CE Mobile Team Concept Reborn after Emergency," *Air Force Civil Engineer*, Vol 3, No 3, 1962, 6-7.

443 Ashdown, 36.

444 Robert D. Little and Wilhelmine Burch, Air Operations in the Lebanon Crisis of 1958," USAF Historical Division Liaison Office, Oct 1962, 71, 74, AHO.

445 Capt. L. Dean Waggoner and 1st Lt. M. Allen Moe, "A History of Air Force Civil Engineering Wartime and Contingency Problems from 1941 to the Present," Thesis, Air University, AFIT, WPAFB, Ohio, September 1985, 193-194; Stanley Kachel, "Lebanon 1958, CE Mobile Team Concept Reborn after Emergency," *Air Force Civil Engineer*, Vol 3, No 3, 1962, 6-7.

446 *Installations Engineer Beacon*, Vol 29, July 1956, 1.

447 Maj. Gen. Augustus M. Minton (USAF, Retired), "Oral History Interview," Interviewed by Lois E. Walker and Dr. Ronald B. Hartzer, HQ AFCESA, Tyndall AFB, Florida, June 2001, 35-36.

448 Ibid.

449 "Air Force Civil Engineers," *TME*, Vol 51, No 335, May-June 1959, 234; General Order 13, 19 March 1959; *Civil Engineering Beacon*, Vol 6, No 57, February-March 1959, 2.

Chapter 3 Endnotes

1 Maj. Gen. Augustus M. Minton, (USAF, Retired), "Oral History Interview," Interview by Dr. Ronald B. Hartzer and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, June 2001, iii; "Maj. Gen. Augustus M. Minton," *Air Force Civil Engineer* [hereafter cited as *AFCE*], Vol 4, No 3, August 1963, 8-9.

2 H. Perry Sullivan, Jr., "Professionalism Personified: Maj. Gen. A.M. Minton," *Air Force Engineering & Services Quarterly*, [hereafter cited as ESQ] Vol 26, No 1, Spring 1985, 21.

3 Maj. Gen. Augustus M. Minton, (USAF, Retired), "Oral History Interview," Interview by Dr. Ronald B. Hartzer and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, June 2001, iii.

4 Ibid. "Maj. Gen. Augustus M. Minton," *AFCE*, Vol 4, No 3, August 1963, 8-9.

5 Maj. Gen. Robert H. Curtin, (USAF, Retired), "Oral History Interview," Interviewed by Lois E. Walker and Dr. Ronald B. Hartzer, HQ AFCESA, Tyndall AFB, Florida, December 2003, v.

6 "Reflections on the Past," *AFCE*, Vol 7, No 3, May 1968, 7-8.

7 Maj. Gen. Robert H. Curtin, "The Director Says…Let's Clean Up the Air and Water Pollution!," *AFCE*, Vol 9, No 2, May 1968, 1.

8 Maj. Gen. Robert H. Curtin, (USAF, Retired), "Oral History Interview," Interviewed by Lois E. Walker and Dr. Ronald B. Hartzer, HQ AFCESA, Tyndall AFB, Florida, December 2003, 46.

9 Ibid., v.

10 "Reflections," *AFCE*, Vol 13, No 1, February 1972, 7-8.

11 Major General Guy H. Goddard, (USAF, Retired), "Oral History Interview," Interviewed by Dr. Ronald B. Hartzer and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, February 2003, v, 17; "Reflections," *AFCE*, Vol 13, No 1, February 1972, 7-8.

12 See Note Above.

13 Lois E. Walker, "A Tradition of Excellence," *The CE*, Vol 7, No 3, Summer 1999, 35.

14 Dr. Ronald B. Hartzer, "Remembering a Founder" Maj. Gen. M.R. (Tex) Reilly," *U.S. AFCE*, Vol 1, No 10, December 1993, 16-17; "What's Ahead?," *AFCE*, Vol 15, No 1, February 1974, 1-9.

15 "What's Ahead?," *AFCE*, Vol 15, No 1, February 1974, 1-9.

16 "Major General B.J. McGarvey Named Director," *AFCE*, Vol 15, No 1, February 1974, 10; Maj. Gen. Billie J. McGarvey, "From the Director…More Than Ever Before, *AFCE*, Vol 15, No 2, May 1974, 1; Maj. Gen. Billie J. McGarvey, "In Retrospect…An Open Letter from the Departing Director," *AFCE*, Vol 16, No 2, May 1975, 7.

17 "The Directorate of Civil Engineering, Headquarters, U.S. Air Force," *The Military Engineer* [hereafter cited as *TME*] Vol 63, No 415, September-October 1971, 319-320.

18 "Directorate of Civil Engineering," *TME*, Vol 52, No 349, September-October 1960, 384.

19 Maj. Gen. Augustus M. Minton, (USAF, Retired), "Oral History Interview," Interview by Dr. Ronald B. Hartzer and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, June 2001, 54.

20 "Directorate of Civil Engineering," *TME*, Vol 52, No 349, September-October 1960, 384.

21 "Maj. Gen. Augustus M. Minton," *AFCE*, Vol 4, No 3, August 1963, 8-9.

22 Maj. Gen. Maurice R. Reilly, "Air Force Civil Engineering: What's Ahead?" *TME*, Vol 66, No 429, January-February 1974, 10-12.

23 Air Staff History January-June 1960, Files of AFCEC History Office, Tyndall AFB, Florida [hereafter cited as AHO]

24 "AFOCE Reorganization," *AFCE*, Vol 1, No 2, May 1960, 20-21.

25 Air Staff History July-December 1961, AHO.

26 Dr. Ronald B. Hartzer, Chronology of Significant Organizational Changes HQ USAF Civil Engineering, n.d., AHO.

27 Air Staff History, July-December 1962, n.p.

28 "Directorate of Civil Engineering U.S. Air Force," *TME*, Vol 56, No 373, September-October 1964, 366.

29 "Directorate of Civil Engineering U.S. Air Force," *TME* Vol 56, No 374, November-December 1964, 447.

30 Col. Robert C. Gardner, "The Civil Engineering Center," *AFCE*, Vol 10, No 1, February 1969, 2-4; William D. Gilbert, "Directorate of Civil Engineering Reorganizes," *AFCE*, Vol 10, No 1, February 1969, 6-7; Air Staff History, January-June 1968, n.p.; Guy H. Goddard, "Concepts of Operations New AFOCE Organization, *AFCE*, Vol 11, No 2, May 1970, 10-12.

31 William D. Gilbert, "Directorate of Civil Engineering Reorganizes," *AFCE*, Vol 10, No 1, February 1969, 6-7.

32 Ibid., 6.

33 Ibid., 6-7.

34 Mr. Harry P. Rietman, (Retired), "Oral History Interview," Interview by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, November 2004, iii.

35 William D. Gilbert, "Directorate of Civil Engineering Reorganizes," *AFCE*, Vol 10, No 1, February 1969, 6-7; Guy H. Goddard, "Concepts of Operations New AFOCE Organization, *AFCE*, Vol 11, No 2, May 1970, 10-12.

36 See Note Above.

37 Air Staff History, January- June 1971, n.p., AHO.

38 Guy H. Goddard, "Concepts of Operations New AFOCE Organization, *AFCE*, Vol 11, No 2, May 1970, 10-12; "The Directorate of Civil Engineering," *TME,* Vol 63, No 415, September-October 1971, 319-320.

39 Air Staff History, July-December 1970, 183.

40 "Air Force Engineer Note," *TME*, Vol 63, No 413, May-June 1971, 201; The Directorate of Civil Engineering," *TME,* Vol 63, No 415, September-October 1971, 319-320.

41 See Note Above.

42 Air Staff History, January-June 1971, n.p., AHO.

43 "The 'New Look' at AF/PRE," *AFCE*, Vol 14, No 1, February 1973, 3; Air Staff History, January-June 1972, n.p., AHO.

44 "New Division in AFCE," *TME*, Vol 67, No 436, March-April, 1975, 104.

45 National Environmental Policy Act (NEPA) of 1969, 42 U.S.C 4321-4347.

46 Lt. Col. A.M. Nemetz, "A New Standard Civil Engineering Command Structure," *AFCE,* Vol 6, No 3, August 1965, 36-37.

47 Air Force Regulation 23-4, 2 June 1965, 1-5.

48 Air Staff History, January-June 1973, n.p., AHO.

49 Maj. Gen. Augustus M. Minton, "Message from the Director…Farewell," *AFCE*, Vol 4, No 3, August 1963, 1.

50 Ibid.

51 Maj. Gen. Augustus M. Minton, (USAF, Retired), "Oral History Interview," Interview by Dr. Ronald B. Hartzer and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, June 2001, 30.

52 Ibid., 33.

53 H. Perry Sullivan, Jr., "Professionalism Personified: Maj. Gen. A.M. Minton," *Air Force Engineering& Services Quarterly*, Vol 26, No 1, Spring 1985, 20.

54 Maj. Gen. Augustus M. Minton, "Message from the Director…," *AFCE*, Vol 2, No 3, August 1961, 1.

55 Maj. Gen. Robert H. Curtin, "The Director Says…New Director Stresses Better Use of Our Engineering Capability, Vol 4, No 4, August 1963, 1.

56 Maj. Gen. Robert H. Curtin, "The Director Says…BALANCE-A System Responsive to Management Needs," *AFCE*, Vol 8, No 3, August 1967, 1.

57 George K. Dimitroff, Editor, "A Chronicle of Progress 1960-1969, *AFCE*, Vol 11, No 1, February 1970, 3.

58 "Hail the '*AFCE*' – Farewell to the Beacon," *Civil Engineering Beacon*, November-December 1959, 1.

59 Lois E. Walker, electronic mail to Dr. Ronald B. Hartzer, 31 March 2006, AHO; George K. Dimitroff, Editor, "A Chronicle of Progress 1960-1969, *AFCE*, Vol 11, No 1, February 1970, 2-5. Dr. Ronald B. Hartzer, "The *Air Force Civil Engineer* Magazine Turns Fifty," *AFCE*, Vol 18, No 1, 2010, 5-8.

60 Maj. Gen. Augustus M. Minton, Memorandum, *Air Force Civil Engineer*, Vol 1, No 1, February, 1960, 3; H. Perry Sullivan, Jr., "Professionalism Personified: Maj. Gen. A.M. Minton," *ESQ*, Vol 26, No 1, Spring 1985, 18.

61 H. Perry Sullivan, Jr., "Professionalism Personified: Maj. Gen. A.M. Minton," *ESQ*, Vol 26, No 1, Spring 1985, 18-21.

62 "Air Force Civil Engineer Innovations," *AFCE*, Vol 2, No 4, November 1961, 1.

63 Maj. Gen. Augustus M. Minton, (USAF, Retired), "Oral History Interview," Interviewed by Lois E. Walker and Dr. Ronald B. Hartzer, HQ AFCESA, Tyndall AFB, Florida, 2001, 13.

64 H. Perry Sullivan, Jr., "Professionalism Personified: Maj. Gen. A.M. Minton," *Air Force Engineering& Services Quarterly*, Vol 26, No 1, Spring 1985, 21.

65 "Journal Marks 13th Year with Aims Toward New Goals," *AFCE*, Vol 13, No 2, May 1971, back cover.

66 Dr. Ronald B. Hartzer, "The Air Force Civil Engineer Magazine Turns Fifty!" Air Force Civil Engineer, Vol 18, No 1, 2010, 5-8.

67 Maj. Gen. Augustus M. Minton, (USAF, Retired), "Oral History Interview," Interview by Dr. Ronald B. Hartzer and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, June 2001, 30.

68 Maj. Gen. Robert H. Curtin, "The Director Says…A Program for Professional Growth," *AFCE*, Vol 6, No 4, November 1965, 1.

69 Maj. Gen. Guy H. Goddard, "The Director Says…Seed Professional Development," *AFCE*, Vol 12, No 4, November 1971, 1.

70 "The Air Force Civil Engineer: Our Ten Commandments of Job Performance," *AFCE*, Vol 6, No 2, May 1965, 37.

71 Maj. John J. Lieb, "Why Registration?," A*ir Force Civil Engineer*, Vol 5, No 1, February 1964, 12-13.

72 Sam S. Nigro, "PRIDE," *AFCE*, Vol 12, No 4, November 1971, 8-9.

73 Lt. Gen. Walter K. Wilson, Jr., "*TME* as Engineer-Manager," *TME,* Vol 56, No 371, May-June 1964, 165-166.

74 Maj. Gen. Augustus M. Minton, "Message from the Director…," *AFCE*, Vol 3, No 4, November 1962, 1.

75 George K. Dimitroff, Editor, "A Chronicle of Progress 1960-1969, *AFCE*, Vol 11, No 1, February 1970,

2; Lewis Shockey, “New Cost Accounting System for Civil Engineering, *AFCE*, Vol 1, No 1, February 1960, 5.

76 George K. Dimitroff, Editor, “A Chronicle of Progress 1960-1969, *AFCE*, Vol 11, No 1, February 1970, 2.

77 Col. G.J. Anzelon, “Network Techniques in Civil Engineering Management-Part I,” *AFCE*, Vol 3, No 3, August 1962, 14-17; Col. G.J. Anzelon, “Network Techniques in Civil Engineering Management-Part II,” *AFCE*, Vol 3, No 4, November 1962, 32-33.

78 Maj. Gen. Augustus M. Minton, “Message from the Director…,” *AFCE*, Vol 3, No 4, November 1962, 1.

79 1st Lt. Donald C. Koford, “Application of CPM in AFRCE-NP MCP Construction,” *AFCE*, Vol 6, No 2, May 1965, 23.

80 Capt. Jimmy Dishner, “Management by Critical Path in Civil Engineering,” *AFCE*, Vol 7, No 4, November 1966, 26-27.

81 Capt. Jimmy G. Dishner, “Reorganization Network,” *AFCE*, Vol 8, No 3, August 1967, 14; Capt. David E. Clapp, “CPM/PERT for Staff Planning,” *AFCE*, Vol 8, No 3, August 1967, 15.

82 Maj. Gen. Robert H. Curtin, “The Director Says…BALANCE-A System Responsive to Management Needs,” *AFCE*, Vol 8, No 3, August 1967, 1.

83 Edward R. Berkowitz, “Balance: Management by Results,” *AFCE*, Vol 9, No 4, November 1968, 2-4, 29.

84 Ibid.

85 Ibid.

86 Robert E. Brandon, “PEACE,” *AFCE*, Vol 10, No 4, November 1969, 2-4.

87 Air Staff History, January-June, 1969, n.p., AHO.

88 Air Staff History, July-December 1968, n.p., AHO.

89 “Major Civil Engineering Objectives for FY1969,” *AFCE*, Vol 9, No 2, May 1968.

90 Air Staff Histories, January-June and July-December 1972, n.p., AHO.

91 A.S. Richards, “Standard Base Civil Engineer Management Review Program,” *AFCE*, Vol 10, No 3, August 1969, 33.

92 Air Staff History, January-June, 1971, n.p., AHO.

93 Air Staff History, July-December, 1969, n.p., AHO.

94 Air Staff History, January-June 1970, n.p., AHO.

95 Air Staff History, July-December 1970, n.p., AHO.

96 A.M. Crawford, “Air Force Civil Engineering Management-A Progress Report,” *AFCE*, Vol 13, No 1, February 1972, 2-5.

97 Brig. Gen. Guy H. Goddard, “AFLC’s Long Range O&M Program,” *AFCE*, Vol 6, No 4, November 1965, 22-23.

98 Lt. Col. Henry G. Snider and Maj. Lewis D. Hollis, “Automation of Total Programming,” *AFCE*, Vol 11, No 2, May 1970, 14-15, 30.

99 Maj. Gen. Guy H. Goddard, “The Director Says…“Integrated Management Systems,” *AFCE*, Vol 10, No 1, February 1969, 1.

100 Lt. Col. Henry G. Snider and Maj. Lewis D. Hollis, “Automation of Total Programming,” *AFCE*, Vol 11, No 2, May 1970, 14-15, 30.

101 Orlando M. Holland, “Total Facility Study,” *AFCE*, Vol 8, No 2, May 1967, 26-28.

102 Air Staff History, January-June 1968, n.p., AHO.

103 Lt. Col. Henry G. Snider and Maj. Lewis D. Hollis, “Automation of Total Programming,” *AFCE*, Vol 11, No 2, May 1970, 14-15, 30.

104 A.M. Crawford, “Air Force Civil Engineering Management-A Progress Report,” *AFCE*, Vol 13, No 1, February 1972, 2-5.

105 Air Staff History, July-December 1973, n.p., AHO.

106 Air Staff History, July-December 1975, n.p., AHO.

107 James A. Gedra and Lt. Col. Joseph Adamo, “AFLC Pilot Test for USAF…Quality Assurance Program,” *AFCE*, Vol 10, No 3, August 1969, 30-32.

108 Capt. Norbert A. O’Hare and Capt. William L. O’Dell, “Building Blocks for a Productive QC&E Program,” *AFCE*, Vol 12, No 1, February 1971, 10-11.

109 *Formal Report of the Civil Engineering Manpower Study Group (Project Prime Beef)*, 1964, 7.

110 Maj. Albert M. Nemetz, “New Civil Engineering AFSC’s,” *AFCE*, Vol 4, No 3, August 1963, 20-22.

111 Maj. Gen. Robert H. Curtin, (USAF, Retired), “Oral History Interview,” Interviewed by Lois E. Walker and Dr. Ronald B. Hartzer, HQ AFCESA, Tyndall AFB, Florida, December 2003, 38.

112 Maj. Gen. Augustus M. Minton, :Message from the Director…,” *AFCE*, Vol 4, No 3, August 1963, 1.

113 Maj. Gen. Robert H. Curtin, (USAF, Retired), “Oral History Interview,” Interviewed by Lois E. Walker and Dr. Ronald B. Hartzer, HQ AFCESA, Tyndall AFB, Florida, December 2003, 38.

114 Maj. Hubert S. Nethercot, “Prime BEEF Base Recovery Forces,” Research Study submitted to the Faculty of Air Command and Staff College, Air University, Maxwell AFB, Alabama, 11, 1973, 13-14.

115 Brig. Gen. William T. Meredith, (USAF, Retired), “Oral History Interview,” Interviewed by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, 2001, 54.

116 *Formal Report of the Civil Engineering Manpower Study Group (Project Prime BEEF)*, 1964, 2-4.
117 Ibid., 7.
118 Ibid.
119 Ibid.
120 Ibid., 6.
121 Ibid.
122 Brig. Gen. William T. Meredith, (USAF, Retired), "Oral History Interview," Interviewed by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, 2001, 55.
123 Lt. Col. William E. Meredith, "Project Prime BEEF Base Engineer Emergency Force," *Air Force Engineer*, Vol 5, No 4, November 1964, 3-5.
124 Ibid., 3-4.
125 Brig. Gen. William T. Meredith, (USAF, Retired), "Oral History Interview," Interviewed by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, 2001, 57.
126 *Formal Report of the Civil Engineering Manpower Study Group (Project Prime BEEF)*, 1964, 12.
127 Ibid., 12-15.
128 Brig. Gen. William T. Meredith, "Project Prime BEEF: Base Engineer Emergency Force," *AFCE*, Vol 5, No 4, November 1964, 2-5.
129 Maj. Hubert S. Nethercot, "Prime BEEF Base Recovery Forces," Research Study submitted to the Faculty of Air Command and Staff College, Air University, Maxwell AFB, Alabama, 1973, 14-15.
130 Brig. Gen. William T. Meredith, (USAF, Retired), "Oral History Interview," Interviewed by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, 2001, 161-162.
131 Maj. Hubert S. Nethercot, "Prime BEEF Base Recovery Forces," Research Study submitted to the Faculty of Air Command and Staff College, Air University, Maxwell AFB, Alabama, 1973, 17, 12.
132 Maj. Gen. Robert H. Curtin, "Air Force Base Engineers' Emergency Forces," *TME*, Vol 57, No 376, March-April 1965, 109.
133 Brig. Gen. William T. Meredith, (USAF, Retired), "Oral History Interview," Interviewed by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, December 2001, 59-60.
134 Capt L. Dean Waggoner and 1st Lt. M. Allen Moe, "A History of Air Force Civil Engineering Wartime and Contingency Problems from 1941 to the Present," Thesis for Air University Air Force Institute of Technology, September 1985 [hereafter cited as Waggoner & Moe], 218.
135 Maj. Gen. Guy H. Goddard, "The Director Says…Use Prime BEEF "E" Team," *AFCE*, Vol 12, No 1, February 1971, 1; Maj. Gen. Guy H. Goddard, "The Director Says…Prime BEEF and RED HORSE Evolution," *AFCE*, Vol 11, No 3, August 1970, 1.November 1967
136 Maj. Hubert S. Nethercot, "Prime BEEF Base Recovery Forces," Research Study submitted to the Faculty of Air Command and Staff College, Air University, Maxwell AFB, Alabama, 1973, 24.
138 Maj. Gen. Robert H. Curtin, "The Director Says…Prime BEEF vs RED HORSE," *AFCE*, Vol 7, No 4, November 1966, 1.
139 Air Staff History, July-December 1975, AHO.
140 Prime Beef Deployments, 1965-1976, AHO.
141 Maj. Thomas S. Collings, "Classification of Civil Engineering Officers," AFCE, Vol 10, No 2, May 1969, 36.
142 William W. Payne, "Standard Base Engineering Position Descriptions…A Program for the Future," AFCE, Vol 12, No 4, November 1971, 26-27.
143 Major General Guy H. Goddard, (USAF, Retired), "Oral History Interview," Interviewed by Dr. Ronald B. Hartzer and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, February 2003, 14.
144 Maj. Gen. William D. Gilbert, (USAF, Retired), "Oral History Interview," Interviewed by Lois E. Walker, AFCESA, Tyndall AFB, Florida, September 2002, 45.
145 Maj. Craig, Major Rabb, Maj. Yow, Capt. Carlstrom, "Palace Blueprint," AFCE, Vol 11, No 2, May 1970, 2-4; Marvin T. Howell, "Palace Blueprint: Six Years Later," Air Force Engineering & Services Quarterly, Vol 17, No 2, May 1976, 31-32, 36; "Project Palace Blueprint, Air Force Times, 19 November 1969, 2.
146 Air Staff History, January-June 1969, n.p., AHO.
147 Lt. Col. R. L. DuBose, "RCAF Construction Engineering," AFCE, Vol 3, No. 4, November 1962, 7-9.
148 "Civil Engineering Officer Exchange Program," *AFCE*, Vol 16, No 1, February 1975, 13-16.
149 "Meet…John R. Gibbens," *AFCE*, Vol 3, No 1, February 1962, n.p.; "Deputy Air Force Civil Engineers," *AFCE*, Vol 19, No 4, 2011, 7; "Deputy Air Force Civil Engineers," *AFCE*, Vol 19, No 4, 2011, 7.
150 "Two Civil Engineering Air men Make History with Reenlistments," *AFCE*, Vol 10, No 3, August 1969, 19.
151 Air Staff History, July-December 1975, n.p., AHO.
152 Msg, HQ AFESC to Multiple Addressees, "Combat Exclusion Policy Regarding Women in the Air Force," 042101Z Aug 88, in History of 554th Civil Engineering Squadron Heavy Repair, Jan-Jun 88, AHO.
153 Col. Susanne M. Waylett,(USAF, Retired), "Oral History Interview," Interviewed by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, 2000, iii-iv, 6, 88.
154 Memo, Maj.Gen. Robert H. Curtin to Multiple Addressees, Subj: Establishment of the Civil Engineering Construction Operations Group, 15 Mar 1966, AHO; Maj. Gen. Robert H. Curtin, (USAF, Retired), "Oral

History Interview," Interviewed by Lois E. Walker and Dr. Ronald B. Hartzer, HQ AFCESA, Tyndall AFB, Florida, December 2003, 45.

155 Air Force Regulation 85-52, "Civil Engineer Construction Operations Group," 16 Sep 1966, AHO.

156 Brig. Gen. William T. Meredith, (USAF, Retired), "Oral History Interview," Interviewed by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, December 2001, viii, 59; William D. Gilbert, "Directorate of Civil Engineering Reorganizes," *AFCE*, Vol 10, No 1, February 1969, 7; Col. Robert G. Gardner, "The Civil Engineer Center," *AFCE,* Vol 10, No 1, February 1969, 2-3.

157 Brig. Gen. William T. Meredith, (USAF, Retired), "Oral History Interview," Interviewed by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, December 2001, 63.

158 Ibid., 64.

159 Ibid., 69.

160 Guy H. Goddard, "Concepts of Operations New AFOCE Organization, *AFCE*, Vol 11, No 2, May 1970, 10-12.

161 Air Staff History, January-June 1968, AHO.

162 Col. Robert G. Gardner, "The Civil Engineer Center," *AFCE,* Vol 10, No 1, February 1969, 2-4; Air Staff History, July–December 1968, n.p.

163 Col. Robert G. Gardner, "The Civil Engineer Center," *AFCE,* Vol 10, No 1, February 1969, 2-4.

164 Capt. John Pelleck, "A Consolidated Effort to Assist CE Organizations Worldwide," *AFCE,* Vol 13, No 4, November 1972, 13-15.

165 Col. Robert G. Gardner, "The Civil Engineer Center*," AFCE,* Vol 11, No 3, August 1970, 30-33.

166 Air Staff History, July-December 1971, n.p., AHO.

167 Air Staff History, January-June 1971, n.p., AHO.

168 Capt. Robert L. Bell, "How to Accomplish a Base Development Plan," *AFCE,* Vol 13, No 1, February 1972, 17-18.

169 Capt. Robert L. Bell, "How to Accomplish a Base Development Plan," *AFCE,* Vol 13, No 1, February 1972, 17-18; Maj. Richard J. Bergholz, "Contingency Planning: A Look into the Future," *AFCE,* Vol 12, No 4, November 1971, 18-19.

170 Air Staff History, January-June 1971, n.p., AHO.

171 Air Staff History, January-June 1970, n.p., AHO.

172 Maj. Robert E. Boyer, "Aircraft Technology vs. Pavement Technology," *AFCE,* Vol 15, No 1, February 1974, 23-26.

173 Air Staff History, January-June 1970, n.p., AHO.

174 Capt. John E. Goin and Capt. William H. Davis, "Technology That's Available to Civil Engineers," *AFCE,* Vol 14, No 3, August 1973, 12-13; Air Staff History, January-June 1971, n.p., AHO.

175 Air Staff History, January-June 1971, n.p., AHO.

176 Air Staff History, January-June 1971, 134, Air Staff History, July-December 1971, n.p., AHO.

177 Air Staff History, July-December 1971, n.p., Air Staff History, January-June 1972, n.p., AHO.

178 Capt. John E. Goin and Capt. William H. Davis, "Technology That's Available to Civil Engineers," *AFCE,* Vol 14, No 3, August 1973, 12-13; Air Staff History, July-December 1971, n.p., AHO.

179 Maj. Hermann R. Engelbach, Jr., and Capt. Peter LoPresti, "The Focus Is On Contingency Planning," *AFCE,* Vol 12, No 3, August 1971, 12-13.

180 Col. Robert G. Gardner, "The Civil Engineer Center*," AFCE,* Vol 11, No 3, August 1970, 30-33.

181 Maj. Gen. William D. Gilbert, (USAF, Retired), "Oral History Interview," Interviewed by Lois E. Walker, AFCESA, Tyndall AFB, Florida, September 2002, 37; Capt. John Pelleck, "A Consolidated Effort to Assist CE Organizations Worldwide," *AFCE,* Vol 13, No 4, November 1972, 13-15; Capt. Robert W. Donley and MSgt. Richard H. Dalrymple, History of Air Force Civil Engineering Center, 29 June 1972 – 30 June 1973, 6.

182 Col. John R. Harty, "An Analysis of Air Force Civil Engineering Research and Development Management," Thesis presented to the Air War College, Air University, Maxwell AFB, Alabama, 1978, 15.

183 Capt. John Pelleck, "A Consolidated Effort to Assist CE Organizations Worldwide," *AFCE,* Vol 13, No 4, November 1972, 13-15; Capt. Robert W. Donley and MSgt. Richard H. Dalrymple, History of Air Force Civil Engineering Center, 29 June 1972 – 30 June 1973, 11; Air Staff History, January-June 1972, n.p., AHO.

184 Lt. Col. Robert E. Crawford, "The Civil Engineering Branch of the Air Force Weapons Laboratory, Air Force Civil Engineer, Vol 9, No 2, May 1969, 2-5; Lt. Col. John R. Harty, "An Analysis of Air Force Civil Engineering Research and Development Management," Thesis presented to the Air War College, Air University, Maxwell AFB, Alabama, 1978, 8.

185 Lt. Col. Robert E. Crawford, "The Civil Engineering Branch of the Air Force Weapons Laboratory, Air Force Civil Engineer, Vol 9, No 2, May 1969, 2-5; Lt. Col. John R. Harty, "An Analysis of Air Force Civil Engineering Research and Development Management," Thesis presented to the Air War College, Air University, Maxwell AFB, Alabama, 1978, 9.

186 Col. David S. Chamberlain, "Civil Engineering Research," *AFCE*, Vol 7, No 2, May 1966, 10-11.

187 Lt. Col. John R. Harty, "An Analysis of Air Force Civil Engineering Research and Development Management," Thesis presented to the Air War College, Air University, Maxwell AFB, Alabama, 1978, 10.

188 Ibid., 11-13.

189 Capt. Robert W. Donley and MSgt. Richard H. Dalrymple, History of Air Force Civil Engineering Center, 29 June 1972 – 30 June 1973, 5-7.
190 Ibid., 1-4.
191 Ibid., 16-18.
192 Lt. Col. John R. Harty, "An Analysis of Air Force Civil Engineering Research and Development Management," Thesis presented to the Air War College, Air University, Maxwell AFB, Alabama, 1978, 17.
193 Major Charles Lindbergh and Captain David Currin, "Field Repair of Airfield Landing Mat Surfacing," *TME*, Vol 64, No 42, November-December 1972, 410.
194 "Technical Review of Rapid Runway Repair History," October 1986, 2, AHO.
195 Guy P. York and Raymond S. Rollings, "Research in Support of Readiness," *ESQ*, Vol 18, No 4, November 1977, 27.
196 History of Air Force Civil Engineering Center, June 1974 – 30 June 1975, 5-6; Telegram, September 1975, AHO.
197 Air Force Systems Command Regulation 23-12, 30 December 1975, 3 pages.
198 History of Air Force Civil Engineering Center, June 1974 – 30 June 1975, 3-5, AHO; Air Staff History, July-December 1975, n.p., AHO.
199 AHO; Air Staff History, July-December 1975, n.p., AHO.
200 James Penn, "Engineering and Services Reservists…Ready Now!," *Air Force Engineering & Services Quarterly*, Vol 26, No 2, Summer 1985, 31-33; Col. William L. Deneke, "Civil Engineering in the Air National Guard," *AFCE*, Vol 7, No 4, November 1966, 14-16.
201 Col. William L. Deneke, "Civil Engineering in the Air National Guard," *AFCE*, Vol 7, No 4, November 1966, 14-16.
202 Ibid.
203 James Penn, "Engineering and Services Reservists…Ready Now!" *Air Force Engineering & Services Quarterly*, Vol 26, No 2, Summer 1985, 31-33.
204 Ibid.
205 Ibid., 32.
206 Ibid., 32.
207 Ibid., 32.
208 Maj. Ernest E. Walkup, Jr., "Modulars-Key to Air Force Flexibility Response," *AFCE*, Vol 11, No 4, November 1970, 18-19.
209 Maj. Matthew M. Cafiso, "Quality is their Hallmark," *AFCE*, Vol 14, No 4, November, 1973, 15-16.
210 Ibid., 14, 16, 18.
211 Maj. James H. Sams and Henry Sauter, "A Highly Professional Force," *AFCE*, Vol 14, No 4, November, 1973, 15, 17, 19.
212 James Penn, "Engineering and Services Reservists…Ready Now!," *Air Force Engineering & Services Quarterly*, Vol 26, No 2, Summer 1985, 32.
213 "RED HORSE Unit Histories," REDHORSE Association, online at http://www.redhorseassociation.org.
214 James Penn, "Engineering and Services Reservists…Ready Now!," *Air Force Engineering & Services Quarterly*, Vol 26, No 2, Summer 1985, 32.
215 Air Force Regulation 23-33, 1 December 1961, 12 pages.
216 Maj. Gen. Augustus M. Minton, "Message from the Director…," *AFCE*, Vol 1, No 4, November 1960, 1.
217 "Maintenance Management," *AFCE*, Vol 1, No 4, November 1960, 3.
218 Col. Henry J. Stehling, "The Control Center Complex-Centralized Complex Boosts Efficiency and Economy," *AFCE*, Vol 2, No 4, November 1961, 10-11.
219 Ibid.
220 Brig. Gen. Archie S. Mayes, (USAF, Retired), "Oral History Interview," Interviewed by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, 2000, v; "Maintenance Management," *AFCE*, Vol 1, No 4, November 1960, 3.
221 Maj. Gen. Augustus M. Minton, "From the Director," *AFCE*, Vol 1, No 4, November 1960, 1.
222 Air Staff History, July-December 1971, n.p., AHO.
223 Brig. Gen. William T. Meredith, (USAF, Retired), "Oral History Interview," Interviewed by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, 2001, 52.
224 "BCE Control Center," *AFCE*, Vol 2, No 2, May 1961, 29.
225 Ray Johnson, "The Control Center: Nerve Center of Base Civil Engineering," *AFCE*, Vol 11, No 4, November 1970, 8, 37.
226 Air Force Regulation 23-33, 1 December 1961, 12 pages; Air Force Regulation 23-33A, 16 December 1964.
227 Air Force Regulation 23-33, 1 December 1961, 3-5.
228 Ibid., 12.
229 Col. Henry J. Stehling, "The Control Center Complex," *AFCE*, Vol 2, No 4, November 1961, 10-12; Air Force Regulation 23-33, 1 December 1961, 12 pages.

230 See Note Above.
231 Air Staff History, January-June 1964, AHO.
232 Air Staff History, July-December 1963, n.p., AHO; "Four Model Bases Certified," *AFCE*, Vol 6, No 3, August 1965, 17; Air Staff History January-June 1967, n.p., AHO.
233 Lt. Col. Norris H. Goodwin, "Control Center Improves Maintenance Effectiveness," *AFCE,* Vol 3, No 3, August 1962, 25.
234 John Ward, Jr., "AFR 23-33 Revision Test," *AFCE,* Vol 7, No 4, November 1966, 6-8.
235 Archie S. Mayes, "Three Keys to Base Civil Engineering Productivity," *AFCE*, Vol 12, No 3, August 1971, 14-15.
236 Ibid.
237 Col. Charles W. Sampson, "Get SMART," *AFCE*, Vol 11, No 4, November 1970, 5-7.
238 Lois E. Walker, "A Tradition of Excellence," *The CE*, Vol 7, No 4, Winter 1999-2000, 28-29.
239 "Directorate of Civil Engineering, U.S. Air Force," *TME*, Vol 57, No 375, January-February 1965.
240 Air Staff History, January-June 1966, n.p., AHO.
241 Maj. Gen. Robert H. Curtin, "The Director Says…The Impact of Austere Funding," *AFCE*, Vol 9, No 1, February 1968, 1.
242 Archie S. Mayes, "Three Keys to Base Civil Engineering Productivity," *AFCE*, Vol 12, No 3, August 1971, 14-15.
243 Air Staff History, January-June 1971, n.p.; Air Staff History, July-December 1971, n.p.; Air Staff History, January-June 1972, n.p.; AHO.
244 Air Staff History, January-June 1963, n.p., AHO.
245 Maj. Gen. Augustus M. Minton, "Message from the Director…," *AFCE,* Vol 2, No 4, November 1961, 1.
246 Mr. Hugh A. Pike, "Oral History Interview," interview by Lois E. Walker, AFCESA, Tyndall AFB, Florida, November 2004, 5.
247 "The P-15," *Air Force Engineering & Services Quarterly*, Vol 17, No 2, May 1976, 24.
248 Charles A. Legates and Sgt. William L. Hause, Jr., "Training with the CB Fire Extinguisher*," AFCE* August 1968, n.p.
249 "Directorate of Civil Engineering, U.S. Air Force," *TME*, Vol 58, No 382, March-April 1966, 127.
250 Air Staff History, January-June 1963, AHO.
251 Maj.Willet R. Stallworth, "Air Force Fire Fighting Equipment: Second to None!" *AFCE*, Vol 15, No 3, August 1974, 6; CMsgt. Robert E. Reyff, "Deliveries Announced: P-23 Now Replacing P-2s Worldwide," *AFCE,* Vol 1, No 3, April 1993, 7.
252 Air Staff History, January-June 1972, n.p., AHO.
253 "Fire Fighter Badge Approved," *AFCE,* Vol 11, No 3, August 1970, back cover.
254 John W. Ward, Jr., "Air Force Cost Reduction Program," *AFCE*, Vol 5, No 2, May 1964, 2-4.
255 Maj. Gen. Robert H. Curtin, "The Director Says…Cost Reduction," *AFCE*, Vol 5, No 2, May 1964, 1.
256 M.J. McAllister, "Cost Reduction Achievements," *AFCE*, Vol 7, No 3, August 1966, 10-11.
257 "Meet…Mr. Lewis E. Turner," *AFCE*, Vol 6, No 4, November 1965, 7.
258 "Air Force Policy," *AFCE*, Vol 3, No 2, May 1962, 15.
259 Air Staff History, July-December 1964, n.p., AHO.
260 Air Staff History, July-December 1965, n.p., AHO.
261 Air Staff History, January-June 1965, n.p., AHO; Charles K. McLeod, "BEAMS: What it Means to the BCE," *Air Force Civil Eng*ineer, Vol 8, No 3, August 1967, 2-3.
262 Air Staff History, January-June 1966, n.p., AHO; Dr. Ronald B. Hartzer, "BEAMS: Firstgen IT for Civil Engineering," Air Force Civil Engineer, Vol 18, No 2, 2010.
263 Air Staff History, July-December 1967, n.p., AHO.
264 Maj. Gen. Robert H. Curtin, "The Director Says…Improved Management Systems," *AFCE*, Vol 8, No 1, February 1967, 1.
265 Donald L. Mang, "BEAMS Today," *AFCE*, Vol 11, No 4, November 1970, 16; Charles K. McLeod, "BEAMS: What it Means to the BCE," *Air Force Civil Eng*ineer, Vol 8, No 3, August 1967, 2-3.
266 "Beams," *TME*, Vol 59, No 387, January-February 1967, n.p.; Donald L. Mang, "BEAMS Today," *AFCE*, Vol 11, No 4, November 1970, 16.
267 Air Staff History, July-December 1967, n.p., AHO.
268 Donald L. Mang, "BEAMS Today," *AFCE*, Vol 11, No 4, November 1970, 16-17, 25.
269 Ibid., 25.
270 Air Staff History, July-December 1970, n.p., AHO.
271 Air Staff History, January-June 1971, n.p., AHO.
272 Donald L. Mang, "BEAMS Today," *AFCE*, Vol 11, No 4, November 1970, 16-17, 25.
273 Air Staff History, July-December 1970, n.p.; Air Staff History, January-June 1971, n.p., AHO.
274 Environmental Protection Agency, "The Challenge of the Environment: A Primer on EPA's Statutory Authority," accessed 31 December 2008, http://www.epa.gov/history/topics/fwpca/05.htm.
275 Environmental Protection Agency, "Origins of Modern Air Pollution Regulations," accessed 3 December 2008, http://www.epa.gov/apti/course422/apc1.html.

276 Maj. Bobbie L. Griffin and Maj. George R. Velasco, *The Air Force Environmental Quality Program: A Historical Look at Air Force Efforts to Achieve Environmental Excellence*, a research paper for Air Command and Staff College, April 1996, 13.

277 Air Staff History, July-December 1970, n.p., AHO.

278 Air Staff History, 1953, n.p., AHO.

279 Air Staff History, 1952, n.p., AHO.

280 Air Staff History, July – December 1965, AHO.

281 *TME*, Vol 58, No 382, March-April 1966, 127.

282 Air Staff History, 1968, AHO.

283 Air Staff History, 1966, AHO; Air Staff History, 1967, AHO.

284 *TME*, Vol 58, No 383, May-June 1966, 202.

285 Air Staff History, 1967, AHO.

286 National Historic Preservation Act of 1966, 16 U.S.C. 470; Air Staff History, July-December 1969, AHO.

287 Richard Nixon, Executive Order 11593 Protection and Enhancement of the Cultural Environment 15 May 1971.

288 National Environmental Policy Act (NEPA) of 1969, 42 U.S.C 4321-4347.

289 Executive Order 12372—Intergovernmental review of Federal programs, 14 July 1982.

290 Air Staff History, 1969, AHO.

291 "Air Force Engineer News," *TME*, January-February 1971, p. 54.

292 Air Staff History, July-December 1970, 1, AHO.

293 Air Staff History, 1973, AHO.

294 *TME,* Vol 71, No 461, May-June 1979, 198, AHO.

295 Air Staff History, July-December 1970, 183.

296 "Air Force Engineer Note," *TME*, Vol 63, No 413, May-June 1971, 201; The Directorate of Civil Engineering," *TME,* Vol 63, No 415, September-October 1971, 319-320.

297 Air Staff History 1970, AHO.

298 Environmental Protection Agency, "Regulations for Open Dumps, Landfills, and Transfer Stations," accessed 11 March 2009, http://www.epa.gov/region09//waste/tribal/reg.html.

299 Capt. Clifford E. Richardson, "Recycling Today for Better Tomorrow," *AFCE*, Vol 14, No 1, February 1973, 21.

300 Air Staff History 1971, AHO.

301 Capt Francis T. Sanpei, and Vernon A. Justice, Jr., "Why Environmental Statements?" *AFCE*, Vol 14, No 1, February 1973, 27.

302 Air Staff History 1971, AHO.

303 Air Staff History 1972, AHO.

304 Environmental Planning, Charles Hudson papers, AHO.

305 Maj. Gen. Robert C. Thompson, "Environmental Planning and the Decision Process," *TME,* Vol 68, No 441, January-February 1976, 12.

306 Jackson County, MO v Jones, 7 Feb 1978, No 77-1739; Air Staff History, Jan-Jun 1977, Environmental Planning Division, 16, AHO.

307 "United States Air Force Pledge to Environmental Protection," *AFCE*, Vol 15, No 1, February 1974, back cover.

308 Air Staff History 1971, AHO.

309 Maj. Gen. Billy J. McGarvey, "From the Director: Meeting Challenges Through Environmental Planning," *AFCE,* Vol 16, No 1, February 1975, 1-2; "Current Emphasis," Air Force Civil Engineer, Vol 14, No 1, February 1973, 1.

310 Brig. Gen. William C. Hall, "The Challenges for Military Engineering in 1975," *TME*, Vol 67, No 435, January-February 1975, 6.

311 Gary D. Vest AIP, "Contemporary Forum of Cooperative Planning," *ESQ*, Vol 17, No 3, August 1976, 9.

312 Ibid.

313 Brigadier General William C. Hall, "The Challenges for Military Engineering in 1975," *TME*, Vol 67, No 435 January-February 1975, 6.

314 Col. William J. Poad Chief, Engineering Division, "Noise Exposure Forecast (NEF) Implementation," Department of the Air Force, Headquarters USAF, Washington D.C., 31 October 1973.

315 Colonel Daniel W. Cheatham, Jr. "Implementation of Military Aircraft Noise Standards" Department of the Air Force, Air Force Aero Propulsion Laboratory, Wright-Patterson AFB, Ohio, 17 July 1974, AHO.

316 Air Staff History 1974, AHO.

317 Air Staff History 1972, AHO.

318 James A. Hill, Lt. Gen, USAF, Deputy Chief of Staff "Air Installation Compatible Use Zone (AICUZ) – policy" Department of the AF, Headquarters USAF, Washington D.C., 17 December 1974.

319 Gary D. Vest AIP, "Contemporary Forum of Cooperative Planning," *Air Force Engineering & Services Quarterly*, Vol 17, No 3, August 1976, 9.

320 Maj. Gen. William D. Gilbert, (USAF, Retired), "Oral History Interview," Interviewed by Lois E. Walker, AFCESA, Tyndall AFB, Florida, September 2002, 86.
321 Roman A. Metz, "No More Yet No Less," *ESQ,* Vol 17 No 3 August 1976, 13.
322 Nicholas J. Lardis, "Energy Crisis and the Air Force," *AFCE*, Vol 14, No 3, August 1973, 3-5.
323 Air Staff History 1973, AHO.
324 Air Staff History 1974, AHO.
325 Air Staff History 1973, AHO.
326 Colonel Vito D. Stipo, "The Defense Energy Conservation Investment Program," *TME,* Vol 68*,* No 442, March-April 1976, 111.
327 Nicholas J. Lardis, "Energy Crisis and the Air Force," *AFCE*, Vol 14, No 3, August 1973, 3-5.
328 "Solar Energy Demonstration," *TME,* Vol 67, No 439, September-October 1975, 300.
329 "Solar Heating Demonstration," *TME,* Vol 67, No 440, November-December 1975, 363.
330 "Energy Conservation Project," *TME,* Vol 67, No 440, November-December 1975, 363.
331 Capt. Anthony Eden and Capt. Michael A. Aimone, "Solar Energy Applications," *Air Force Engineer & Services Quarterly*, Vol 17, No 3, August 1976, 29.
332 Ibid.
333 Capt. Anthony Eden and Paul F. Neal, "Electricity from the Sun," *ESQ*, Vol 18, No 3, August 1977.
334 Air Staff History 1975, AHO.
335 Ibid.
336 Maj. Gen. Maurice R. Reilly, "Air Force Construction Program," *TME*, Vol 64, No 419, May-June 1972, 169.
337 Ibid.
338 Ibid.
339 Col. James F. Carney and Lt. Col. Don B. Moon, "The Air Force Regional Civil Engineers," *AFCE*, Vol 4 No 3, August 1963, 32-35.
340 "What's Ahead?," *AFCE*, Vol 15, No 1, February 1974, 1-9.
341 "AFCE Leaders You Should Know…James F. Boatright," *AFCE*, Vol 13, No 1, February 1972, 10.
342 Maj. H.W. Underhill, Jr., "WADD Proves Air Force is Design Agency," *AFCE*, Vol 1 No 1, February 1960, 3-4, 28.
343 Air Staff History, July-December 1972, n.p., AHO.
344 "AFCE Leaders You Should Know…James F. Boatright," *AFCE*, Vol 13, No 1, February 1972, 10; A. M. Crawford, "Air Force Civil Engineering Management-A Progress Report," *AFCE*, Vol 13, No 1, February 1972, 2-5.
345 Maj. Gen. M.R. Reilly, "Air Force Construction Program," *TME*, Vol 64, No 419, May-June 1972, 169; T. E. Lawson, "Two Step Procurement," *AFCE*, Vo. 6, No 3, August 1965, 15.
346 T. E. Lawson, "Two Step Procurement," *AFCE*, Vo. 6, No 3, August 1965, 15.
347 Air Staff History, January- June 1969, n.p.
348 Thomas L. Lord, "More and Better Housing for Air Force Families," *AFCE*, Vol 13, No 4, November 1972, 10-11.
349 Capt. Michael Burrill, "Good Houses for Unknown Clients," *AFCE*, Vol 16, No 2, May 1975, 16-21.
350 Maj. Gen. Guy H. Goddard, "The Director Says…Industrialized Construction," *AFCE*, Vol 12, No 2, May 1971, 1.
351 Air Staff History, January-June 1971, n.p., AHO.
352 Air Staff History, July-December 1971, n.p., AHO.
353 Air Staff History, January-June 1971, n.p., AHO; Maj. Gen. Guy H. Goddard, "The Director Says… Industrialized Construction," *AFCE*, Vol 12, No 2, May 1971, 1.
354 Air Staff History, July-December 1972, n.p., AHO.
355 Ibid.
356 Col. John R. Harty, An Analysis of Air Force Civil Engineering Research and Development Management, Thesis presented to the Air War College, Air University, Maxwell AFB, Alabama, 1978, 8.
357 Robert J. Alexander, "The ACFE's Place in Space," *AFCE*, Vol 4, No 1, February 1963, 18-19; 2d Lt. B.A. Collins, Jr., "486L MED COM," *AFCE*, Vol 7, No 1, February 1966, 6-7.
358 Maj. Gen. Joseph A. Ahearn, (USAF, Retired), "Oral History Interview," Interview by Lois E. Walker and Douglas H. Merkle, HQ AFCESA, Tyndall AFB, Florida, March 2008, vi.
359 Lt. Col. Alfred Kaufman, "AFCE's Responsible for Rapid Evolution," *AFCE*, Vol 3, No 2, May 1962, 4-5.
360 1st Lt. James R. Hawkins, "Mandatory Engineering Registration for Air Force Civil Engineers," *AFCE*, Vol 3, No 3, August 1962, 11-12.
361 Capt R.C.B. Wright, "TITAN III and the Air Force Civil Engineer," *AFCE*, Vol 6, No 1, February 1965, 9.
362 John C. Lonnquest and David Winkler. *To Defend and Deter: The Legacy of the United States Cold War Missile Program*. United States Army Construction Engineering Research Laboratories, Champaign, Illinois, Sponsored by Department of Defense Legacy Resource Management Program, 1996, 79; Capt. RCB Wright, "TITAN III and the Air Force Civil Engineer," *AFCE*, Vol 6, No 1, February 1965, 6-9.

363 John C. Lonnquest and David Winkler. *To Defend and Deter: The Legacy of the United States Cold War Missile Program*. United States Army Construction Engineering Research Laboratories, Champaign, Illinois, Sponsored by Department of Defense Legacy Resource Management Program, 1996, 52, 241; Office of the Historian HQ SAC, "Snark to Peacekeeper A Pictorial History of Strategic Air Command Missiles," HQ SAC, Offutt Air Force Base, Nebraska, 1990, 13-15; Timothy C Hanley and Harry N Waldron, "Historical Overview Space and Missile Systems Center, 1954-1995. Electronic document available at www.fas.org/spp/military/program/SMC_hist, Accessed 2 March 2009, Federation of American Scientists.

364 Air Staff History, Directorate of Civil Engineering, January-June 1962, n.p., AHO.

365 "ICBM Facility Program Wins ASCE Award," *AFCE*, Vol 3, No 2, May 1962, 2.

366 Robert J. Alexander, "The AFCE's Place in Space," *AFCE*, Vol 4, No 1, February 1963, 19-21.

367 Ibid.

368 John C. Lonnquest and David Winkler. *To Defend and Deter: The Legacy of the United States Cold War Missile Program*. United States Army Construction Engineering Research Laboratories, Champaign, Illinois, Sponsored by Department of Defense Legacy Resource Management Program, 1996, 234.

369 Maj. Bill E. Polasek, Jr., "Missile Support Training for Civil Engineers," *AFCE*, Vol 5, No 3, August 1964, 18-20.

370 1st Lt. John G. Terino, "A New Breed…the CE Missile Officer," *AFCE*, Vol 6, No 2, May 1965, 18.

371 Gene T. Mahoney, "SAC Grouting Team Does it Again!," *AFCE*, Vol 8, No 3, August 1967, 30-31.; Capt. William E. Craig, "One of a Kind…The SAC Grout Team," *AFCE*, Vol 12, No 4, November 1971, 14-16.

372 Office of the Historian HQ SAC, "Snark to Peacekeeper A Pictorial History of Strategic Air Command Missiles," HQ SAC, Offutt Air Force Base, Nebraska, 1990, 43.

373 "A Bold Concept in Air Force Passenger Terminals, *AFCE*, Vol 14, No 2, May 1973, 4-6.

374 Ibid.

375 Capt. John F. Gaver, "Breakthrough in Air Cargo Terminals," Air Force Civil Engineer, Vol 14, No 4, November 1973, 7-10.

376 Ibid.

377 John F. Maiorano, "Modernized Logistics Depots," *AFCE*, Vol 14, No 4, November 1973, 2-6.

378 Ibid.

379 John F. Maiorano, "Modernized Logistics Depots," *AFCE*, Vol 14, No 4, November 1973, 2-6; Air Staff History, January-June 1972, 77; January-June 1973, n.p.; January-June 1974, 96; July-December 1974, 96; January-June 1975, 96, AHO.

380 Air Staff History, January-June 1970, n.p., AHO.

381 Air Staff History, July-December 1972, n.p., AHO.

382 Capt. Eugene A. Lupia, PE, "TLQs: A People Program," *AFCE*, Vol 14, No 1, February 1973, 16.

383 Department of Defense, "NASA Aeronautics Facilities Critical to DoD Report to Congress," January 2007, 3.

384 Directorate of Installations History, July-December 1950, AHO.

385 Arnold Engineering Development Center, "2008 Test Facility Guide, Test Before Flight," 2008, 1-2; "Aeropropulsion Systems Test Facility," U.S. Air Force Fact Sheet, accessed 12 November 2008, http://www.arnold.af.mil/library/factsheets/.

386 Maj. Chandis Klinger and Gottfried M. Arnold, "Correcting a Serious Deficiency," *AFCE*, Vol 15, No 2, May 1974, 26-29; Donald J. Horan, Director Procurement, Logistics, and Readiness Division, Letter to Senator Sasser, 30 September 1982, *Cost Overrun on the Aeropropulsion Systems Test Facility*, AHO.

387 Air Staff History 1974, AHO.

388 Maj. Chandis Klinger and Gottfried M. Arnold, "Correcting a Serious Deficiency," *AFCE*, May 1974, 26-29; Marvin J. Kudroff, "The Aeropropulsion Systems Test Facility," *TME*, Vol 67, No 437, May-June 1975, n.p; "Aeropropulsion Systems Test Facility," U.S. Air Force Fact Sheet, accessed 12 November 2008, http://www.arnold.af.mil/library/factsheets/.

389 Air Staff History 1976, AHO; "Aeropropulsion Systems Test Facility," U.S. Air Force Fact Sheet, accessed 12 November 2008, http://www.arnold.af.mil/library/factsheets/; Department of Defense, "NASA Aeronautics Facilities Critical to DoD Report to Congress," January 2007, 3.

390 Air Staff History 1974, AHO; Air Staff History 1976, AHO; Arnold Air Force Base, "Aeropropulsion Systems Test Facility," U.S. Air Force Fact Sheet, accessed 12 November 2008, http://www.arnold.af.mil/library/factsheets/.

391 North American Aerospace Defense Command and United States Space Command, "The Cheyenne Story," ca. 1995, from the AHO.

392 Maj. Gen. Augustus Minton, (USAF, Retired), "Oral History Interview," Interview by Dr. Ronald B. Hartzer and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, February 2001, 49; John M. Norvell, "What Have We Learned for NORAD's Cheyenne Mountain?," *AFCE*, Vol 9, No 3, August 1968, 18-21.

393 Air Force Space Command, "Fact Sheet Peterson AFB," 1992, AHO; Merwin H. Howes, "Methods and Costs of Constructing the Underground Facility of North American Air Defense Command at Cheyenne Mountain, El Paso County, Colorado," information circular 8294, U.S. Department of the Interior, Bureau of Mines, 1966, 1;4-5;49.

394 Maj. Gen. Augustus Minton, (USAF, Retired), "Oral History Interview," Interview by Dr. Ronald B.

Hartzer and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, February 2001, 49.

395 Air Force Space Command, "Fact Sheet Peterson AFB," 1992, from the AHO.

396 North American Aerospace Defense Command and United States Space Command, "The Cheyenne Story," ca. 1995, from the AHO.

397 Ibid.

398 Air Force Space Command, "Fact Sheet Peterson AFB," 1992, from the AHO

399 Brig. Gen. Billie J. McGarvey, "The New Air Force Museum," *AFCE*, Vol 12, No 1, February 1971, 2-5.

400 Ibid.

401 Brig. Gen. Billie J. McGarvey, "The New Air Force Museum," *AFCE*, Vol 12, No 1, February 1971, 2-5; National Museum of the U.S. Air Force, accessed 18 July 2011, http://www.nationalmuseum.af.mil/index.asp.

402 National Museum of the U.S. Air Force, accessed 18 July 2011, http://www.nationalmuseum.af.mil/index.asp.

403 Simon Duke, *United States Military Forces and Installations in Europe*, Oxford University Press, New York, 1989, 149-151.

404 Simon Duke, *United States Military Forces and Installations in Europe*, Oxford University Press, New York, 1989, 149-151.; "Withdrawal from France 1966-67 Operation FRELOC (Fast Relocation), n.d., 1-3, AHO.

405 Col. Robert T. Greigg, "Operation FRELOC," *AFCE*, Vol 9 No 1, Feb 1968, 8-10; "Withdrawal from France 1966-67 Operation FRELOC (Fast Relocation), n.d., 1-3, AHO.

406 Maj.Ulrich H. Lettau, " COBs in Europe," *ESQ,* Vol 22, No 2, Summer 1981, 21.

407 Lt. Col. Charles Lindbergh, "USAFE Operational Readiness: A Challenge to Military Engineering," *Engineering & Services Quarterly*, Vol 18, No 4, November 1977, 18; CMSgt. Dave Brown, CMSgt. (Ret.) Marshall B. "Doc" Dutton, SMGt. Marshall G. "Baby Doc" Dutton, "Air Force EOD's Move, USAF Exploded Ordnance Disposal (EOD), From Maintenance to Civil Engineering," no date, AHO.

408 Capt. Robert M. Gogal, "Passive Defenses for Air Bases" *TME*, Vol 61, No 404, 416-417.

409 Maj. Herbert G. Campbell, "Protective Aircraft Shelter," *AFCE*, Vol 10, No 2, May 1969, 3; History of 560th Civil Engineering Squadron (Heavy Repair), 1 Jul-31 Dec 1967, AHO

410 Air Staff History, July –December 1966, n.p., AHO.

411 Lt. Col. Floyd A. Ashdown, "A History of the Warfighting Capability of Air Force Civil Engineering," Research Report, Air War College Air University Maxwell Air Force Base, Alabama, May 1984, 65; 69; Col. Robert G. Gardner, "The Civil Engineer Center," *AFCE,* Vol 11, No 3, August 1970, 30-33.

412 Maj. Herbert G. Campbell, "Protective Aircraft Shelter," *AFCE*, Vol 10, No 2, May 1969, 2-5.

413 Air Staff History, July-December 1969, n.p.; 1st Lt. Richard C. Eddy, "History, 554th Civil Engineering Squadron (HR) 1 Jan-31 Mar 1970," 35, AHO

414 Maj. Herbert G. Campbell, "Protective Aircraft Shelter," *AFCE*, Vol 10, No 2, May 1969., 3

415 Ibid.

416 Capt. Paul Y. Thompson, "Aircraft Shelters in Vietnam," *TME*, Vol 61, No 402, July-August 1969, n.p.; Col. Lindsey M. Silvester, USAF Director of Tactical Evaluation DCS/Operations; Letter of Transmittal PACAF CORONA HARVEST Studies, 23 October 1970, 170; Capt. Robert M. Gogal, "Passive Defenses for Air Bases" *TME*, Vol 61, No 404, 416-417.

417 Lt. Col. Floyd A. Ashdown, "A History of the Warfighting Capability of Air Force Civil Engineering," Research Report, Air War College Air University Maxwell Air Force Base, Alabama, May 1984,79-80; Air Staff History, July-December 1970, n.p.; Lt. Col. Rudolph V. Matalucci, "Meeting an Operational Need," *Engineering & Services Quarterly*, Vol 18, No 1 February 1977, 7-10.

418 Air Staff History, January-June 1969, n.p.; Air Staff History, January-June 1970, n.p.; Air Staff History, July-December 1970, n.p.; Air Staff History, January-June 1971, n.p.

419 Air Staff History, July-December 1974.

420 Lt. Col. Charles Lindbergh, "USAFE Operational Readiness, A Challenge to Military Engineering," *ESQ*, Vol 18, No 4, November 1977, 21.

421 Air Staff History, January-June 1969, n.p.; Air Staff History, January-June 1970, n.p.; Air Staff History, July-December 1970, n.p.; Air Staff History, January-June 1971, n.p.

422 Capt. Donald W. Klick, "Project ICE WAY," *AFCE*, Vol 3, No 2, May 1962, 32-33.

423 Ibid., 32-35.

424 "Special Short Course Programs for AFCE," *AFCE Magazine*, Vol 4, No 2, May 1963, 20.

425 Maj Gen. Robert H. Curtin, "Air Force Base Engineers' Emergency Forces," *TME*, March-April 1965, 108.

426 "Civil Engineer Center Changes Name; Becomes Civil Engineering School," *AFCE*, Vol 9, No 2, May 1968, 33; Ernest A. Pinson, "AFIT Anniversary, the First Fifty Years," *AFCE*, Vol 10, No 3, August 1969, back cover.

427 "Operation Cool School," *AFCE*, Vol 2, No 4, November 1961, 34-36.

428 Ibid.

429 Maj. Gen. Augustus Minton, (USAF, Retired), "Oral History Interview," Interview by Dr. Ronald B. Hartzer and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, February 2001, 30-31.

430 "Operation Cool School," *AFCE*, Vol 2, No 4, November 1961, 34-36; Eugene E. Peer, "History of the Civil Engineering School," November 1976, manuscript, AHO.

431 "Operation Cool School," *AFCE*, Vol 2, No 4, November 1961, 34-36.

432 Maj. Gen. Augustus Minton, (USAF, Retired), "Oral History Interview," Interview by Dr. Ronald B. Hartzer and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, February 2001, 31.

433 "Operation Cool School," *AFCE*, Vol 2, No 4, November 1961, 34-36; Dr. Ronald B. Hartzer, "Operation COOL SCHOOL," *AFCE*, May 1990, 3-4; Mr. Harry P. Rietman, (Retired), "Oral History Interview," Interview by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, November 2004, 30-31.

434 "Applied Engineering Course," *AFCE*, Vol 6, No 2, May 1965, 15; Eugene E. Peer, "History of the Civil Engineering School," November 1976, manuscript, AHO.

435 Lt. Col. B.C. Wylie, "AFCE Professional Education and TWI Programs," *AFCE Magazine*, Vol 3, No 4, November 1962, 30; 1st Lt. Michael H. Perry, "Education-With-Industry Program for Engineers," *AFCE Magazine*, Vol 8, No 2, May 1967, 17; Maj.Donald W. Campbell, PE, "IBM's EWI Program," *AFCE Magazine*, Vol 5, No 4, November 1964, 22.

436 Lt. Col. B.C. Wylie, "AFCE Professional Education and TWI Programs," *AFCE Magazine*, Vol 3, No 4, November 1962, 30.

437 Maj.Donald W. Campbell, PE, "IBM's EWI Program," *AFCE Magazine*, Vol 5, No 4, November 1964, 21-22.

438 Capt Michael H. Perry, "EWI an Unequaled Educational Experience," *AFCE Magazine*, Vol 9, No 4, November 1968, 6, 29.

439 Ibid.

440 Ibid.

441 "Special Short Course Programs for AFCE," *AFCE Magazine*, Vol 4, No 2, May 1963, 20; "Civil Engineering FY-66 Short Courses,"*AFCE*, Vol 6, No 2, May 1965, 16.

442 Lt. Col. B. C. Wylie, "AFCE Professional Education and TWI Programs," *AFCE Magazine*, Vol 3, No 4, November 1962, 30-31.

443 Maj.Robert L. Sims, Associate Professor of Management Sciences, "2 New Degree Programs for Civil Engineers, Civil Engineering Facilities Management," *AFCE Magazine*, Vol 14, No 2, May 1973, 11-13.

444 "Professor J. Richardson "Rich" Johnson, "Oral History Interview," Interviewed by Mrs. Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, December 2003, 21; Eugene E. Peer, "History of the Civil Engineering School," November 1976, manuscript, AHO.

445 Col. Winston C. Fowler, PE, "The Civil Engineering Curriculum at the USAF Academy," *AFCE Magazine*, Vol 8, No 2, May 1967, 2-3.

446 Col. Winston C. Fowler, PE, "The Civil Engineering Curriculum at the USAF Academy," *AFCE Magazine*, Vol 8, No 2, May 1967, 2-3; "Outstanding Cadet Award Presented at Air Force Academy," *AFCE Magazine*, Vol 13, No 3, 1972, 29.

447 Lt. Col. George Talbot, PE, "Training for…Civil Engineering Technicians," *AFCE Magazine*, Vol 4, No 4, November 1963, 18.

448 Ibid., 18-20.

449 Maj. Bill E. Polasek, Jr., "Missile Support Training for Civil Engineers," *AFCE*, Vol 5, No 3, August 1964, 18-20.

450 1st Lt. John G. Terino, "A New Breed…the CE Missile Officer," *AFCE*, Vol 6, No 2, May 1965, 18.

451 Douglas E. Courchene, *Pioneers with Intent, Memoirs of an Air Force Fire Fighter*, Air Force Civil Engineer Support Agency, Tyndall AFB July 2003, 56; "Air Force & DOD Fire Academy History," n.d., AHO.

452 Eugene E. Peer, PE, "The Professional Degree Program," *AFCE*, Vol 12, No 4, November 1971, 2-5.

453 Capt. Herbert L. Hollar, "Making the Civil Engineering Program Work," *AFCE*, Vol 15, No 2, May 1974, 18-20.

454 1st Lt. Edward M. Carpenter, "Education for Civilians," *AFCE*, Vol 8, No 2, May 1967, 12.

455 Robert P. Grathwol and Donita M. Moorhus*, Building for Peace: U.S. Army Engineers in Europe, 1945-1991,* Government Printing Office, U.S. Army Center for Military History, Washington, D.C., 2005, 133.

456 Brig. Gen. Oran O. Price, "Berlin – 1961, Facility Buildup a Challenge to the AFCE," *AFCE,* Vol 3, No 3, August 1962, 2-5.

457 Lt. Col. Floyd A. Ashdown, "A History of the Warfighting Capability of Air Force Civil Engineering," Research Report, Air War College, Air University, Maxwell Air Force Base, Alabama May 1984, 38.

458 Brig. Gen. Oran O. Price, "Berlin – 1961, Facility Buildup a Challenge to the AFCE," *AFCE,* Vol 3, No 3, August 1962, 2-5.

459 Robert P. Grathwol and Donita M. Moorhus, *Building for Peace: U.S. Army Engineers in Europe, 1945-1991*, Government Printing Office, U.S. Army Center for Military History, Washington, D.C., 2005.

460 Brig. Gen. Oran O. Price, "Berlin – 1961, Facility Buildup a Challenge to the AFCE," *AFCE,* Vol 3, No 3, August 1962, 5.

461 Stephen Ambrose, *Rise to Globalism: American Foreign Policy 1938-1970*, Penguin Books, Inc., Baltimore, Maryland, 1971, 289.

462 Maj. Gen. Augustus M. Minton, (USAF, Retired), "Oral History Interview," Interviewed by Lois E. Walker and Ronald B. Hartzer, HQ AFCESA, Tyndall AFB, Florida, 2001, 45.

463 Maj. Morris B. Rubenstein, "We Opened Opalocka," *AFCE*, Vol 4, No 4, November 1963, 8-9.
464 Maj. Gen. Joseph A. Ahearn (USAF, Retired), "Oral History Interview," Interviewed by Lois E. Walker and Dr. Douglas Merkle, HQ AFCESA, Tyndall AFB, Florida, March 2008, 18.
465 Maj. Hubert S. Nethercot, "Prime BEEF Base Recovery Forces," Research Study submitted to the Faculty of Air Command and Staff College, Air University, Maxwell AFB, Alabama, 1973, 11.
466 Capt. Maurice K. Robinson, "Bare Base," *AFCE*, Vol 8, No 3, May 1967, 18.
467 Richard A. Haggerty, editor, Dominican Republic: A Country Study, Government Printing Office, Washington, D.C., 1989, viewed online May 2011, http://countrystudies.us/dominican-republic.
468 Capt. R. J. Oelke, EIT, "Prime BEEF Goes to Santo Domingo," *AFCE*, Vol 7, No 1, February 1966, 16-18.
469 Ibid.
470 Ibid.
471 R.R. Palmer and Joel Colton, *A History of the Modern World*, Alfred A. Knopf, New York, New York, 1978, 920.
472 Ibid.
473 Ibid.
474 John Lewis Gaddis, *The Cold War. A New History,* The Penguin Press, New York, New York, 2005, 132.
475 Waggoner & Moe, 204.
476 John Schlicht, *A War Too Long: The USAF in Southeast Asia 1961-1975*, Air Force History and Museums Program, 1996, 10, 5-6, 8, 11.
477 John Schlicht, *The War in South Vietnam: The Years of the Offensive, 1965-1968*, Air Force History and Museums Program, 1999, 5.
478 John Schlicht, *A War Too Long: The USAF in Southeast Asia 1961-1975*, Air Force History and Museums Program, 1996, 10, 5-6, 8, 11.
479 Stephen E. Ambrose, *Rise to Globalism. American Foreign Policy 1938-1970*, Penguin Books, Inc., Baltimore, Maryland, 1971, 311.
480 John Schlicht, *A War Too Long: The USAF in Southeast Asia 1961-1975*, Air Force History and Museums Program, 1996, 17.
481 Waggoner & Moe, 204.
482 Chester G. Hearn, *Air Force: An Illustrated History*, Zenith Press, Minneapolis, Minnesota, 2008, 131-132.
483 Waggoner & Moe, 204; John Schlicht, *The War in South Vietnam: The Years of the Offensive, 1965-1968*, Air Force History and Museums Program, 1999, 5.
484 See Note Above.
485 USAF Logistics Activities in Support Operations On Southeast Asia, 1 January 1965-31 December 1969, 150-152, Project Corona Harvest, Air Force Historical Research Agency, Maxwell AFB, Alabama; Waggoner & Moe, 206.
486 Col. I.H. Impson, "Southeast Asia 1962," *AFCE*, Vol 4, No 1, February 1963, 2-6.
487 Lt. Col. Maynard G. Hamilton, "Base Operation and Maintenance, SEA" *AFCE*, Vol 9, No 2, May 1968, 14-15.
488 USAF Logistics Activities in Support Operations On Southeast Asia, 1 January 1965-31 December 1969, 152, 150, Project Corona Harvest, Air Force Historical Research Agency, Maxwell AFB, Alabama.
489 Ibid., 150-151.
490 Waggoner & Moe, 206.
491 Ibid., 226.
492 Steve Canton, "This Air Force Colonel Wears Four Hats," *AFCE,* Vol 8, No 1, 1967, 2-7.
493 Col. I.H. Impson, "Southeast Asia 1962," *AFCE*, Vol 4, No 1, February 1963, 2-6.
494 Lt. Col. Floyd A. Ashdown, "A History of the Warfighting Capability of Air Force Civil Engineering," Research Report, Air War College, Air University, Maxwell Air Force Base, Alabama May 1984, 44-46.
495 USAF Logistics Activities in Support Operations On Southeast Asia, 1 January 1965-31 December 1969, 164, Project Corona Harvest, Air Force Historical Research Agency, Maxwell AFB, Alabama.
496 Capt. David M. De Blonk and Col. Robert G. Gardner, "A HQ USAF Directorate of Civil Engineering (AFOCE) Activity Input to Project Corona Harvest on Civil Engineering Support in SEA 1 January 1965 – 31 March 1968," Submitted 18 December 1969 by the USAF Civil Engineering Center, 6-7.
497 Maj. David G. Kestner, "The Changing Role of the AFRCE in Vietnam," *AFCE*, Vol 11, No 2, May 1970, 8-9, 37.
498 USAF Logistics Activities in Support Operations On Southeast Asia, 1 January 1965-31 December 1969, 153-154, 160, Project Corona Harvest, Air Force Historical Research Agency, Maxwell AFB, Alabama.
499 Ibid., 153-154.
500 Lt. Col. Warren B. Graves, "The Military Construction Program in Action," *AFCE,* Vol 9, No 2, May 1968, 28-29.
501 USAF Logistics Activities in Support Operations On Southeast Asia, 1 January 1965-31 December 1969, 153-154, Project Corona Harvest, Air Force Historical Research Agency, Maxwell AFB, Alabama.

502 Ibid., 155.

503 Steve Canton, “This Air Force Colonel Wears Four Hats,” *AFCE,* Vol 8, No 1, 1967, 2-7.

504 Maj. Gen. R. H. Curtin, “The Director Says…Let’s Be Ready…Professionally,” *AFCE,* Vol 6, No 3, August 1965, 1.

505 “Regional Civil Engineer SEA,” *AFCE*, Vol 6, No 3, Aug 1965, 16; Maj. David G. Kestner, “The Changing Role of the AFRCE in Vietnam,” *AFCE*, Vol 11, No 2, May 1970, 8-9, 37; Steve Canton, “This Air Force Colonel Wears Four Hats,” *AFCE,* Vol 8, No 1, 1967, 2-7.

506 Steve Canton, “This Air Force Colonel Wears Four Hats,” *AFCE,* Vol 8, No 1, 1967, 2-7; Brig. Gen. Archie S. Mayes, (USAF, Retired), “Oral History Interview,” Interviewed by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, 2000, 63.

507 Capt. David M. De Blonk and Col. Robert G. Gardner, “A HQ USAF Directorate of Civil Engineering (AFOCE) Activity Input to Project Corona Harvest on Civil Engineering Support in SEA 1 January 1965 – 31 March 1968,” Submitted 18 December 1969 by the USAF Civil Engineering Center, 15, 85-86, 234-5.

508 Brig. Gen. Archie S. Mayes, (USAF, Retired), “Oral History Interview,” Interviewed by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, 2000, 62.

509 Ibid.

510 Maj. David G. Kestner, “The Changing Role of the AFRCE in Vietnam,” *AFCE*, Vol 11, No 2, May 1970, 8-9, 37.

511 Steve Canton, “This Air Force Colonel Wears Four Hats,” *AFCE,* Vol 8, No 1, 1967, 2-7.

512 Ibid.

513 Ibid.

514 Col. I.H. Impson, “Southeast Asia 1962,” *AFCE*, Vol 4, No 1, February 1963, 2-6.

515 Steve Canton, “This Air Force Colonel Wears Four Hats,” *AFCE,* Vol 8, No 1, 1967, 2-7.

516 Maj. Gen. R. H. Curtin, “The Director Says…Prime BEEF Teams…’Excellent’,” *AFCE,* Vol 7, No 1, February 1966, 1.

517 Lt. Col. Howard B. Arnold, Jr. “A New Image for the AFCE in Vietnam,” *AFCE,* Vol 7, No 2, May 1966, 6-7.

518 Col. Kaufman, Lt. Col. Torr, Maj. Fearn, and Capt. Bratton, “Vietnam Report: Prime BEEF in Action,” *AFCE*, Vol 7, No 1, February 1966, 3; John Schlight, *The Years of the Offensive, 1965-1968*, Office of Air Force History, Washington DC, 1988, 45; “Civil Engineers Killed During Contingency Operations, AHO.

519 Col. Kaufman, Lt. Col. Torr, Maj. Fearn, and Capt. Bratton, “Vietnam Report: Prime BEEF in Action,” *AFCE*, Vol 7, No 1, February 1966, 2-5; Steve Canton, “This Air Force Colonel Wears Four Hats,” *AFCE,* Vol 8, No 1, 1967, 2-7.

520 Mr. Jean Martin, SSgt Douglas W. Stephens, SSgt Robert F. Jakob, Historical Division, Directorate of Information, Headquarters Seventh Air Force, “Airfield Construction in Southeast Asia, July 1965-March 1967,” 1-13, Air Force Historical Research Agency, Maxwell AFB, Alabama.

521 Ibid.; Prime BEEF Team 6 Historical Report, 1966, 3, AHO; Capt. Gary B. Lauson, “Civil Engineering Combat Experiences during the Vietnam War: An Exploratory Study,” Thesis for Air Force Institute of Technology, WPAFB, Ohio, 1989, 22-23.

522 Prime Beef Deployments, 1965-1976, AHO.

523 Brig. Gen. Archie S. Mayes, (USAF, Retired), “Oral History Interview,” Interviewed by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, 2000, 63.

524 Directorate of Civil Engineering (DCS/P&R), “Air Staff History,” January-June 1966, n.p., AHO; Steve Canton, “This Air Force Colonel Wears Four Hats,” *AFCE,* Vol 8, No 1, 1967, 2-7.

525 Steve Canton, “This Air Force Colonel Wears Four Hats,” *AFCE,* Vol 8, No 1, 1967, 2-7.

526 Maj. Gen. R. H. Curtin, “The Director Says…Prime BEEF Teams…’Excellent’,” *AFCE,* Vol 7, No 1, February 1966, 1.

527 Secretary of Defense, Memorandum for the Secretary of the Air Force, 10 May 1965.

528 USAF Logistics Activities in Support Operations On Southeast Asia, 1 January 1965-31 December 1969, 160, Project Corona Harvest, Air Force Historical Research Agency, Maxwell AFB, Alabama.

529 Ibid.

530 Lt. Col. Floyd A. Ashdown, “A History of the Warfighting Capability of Air Force Civil Engineering,” Research Report, Air War College Air University Maxwell Air Force Base, Alabama May 1984, 52.

531 Brig. Gen. William T. Meredith, (USAF, Retired), “Oral History Interview,” Interviewed by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, 2001, 68.

532 Air Force Office of Civil Engineering, “A Study: Prime BEEF Heavy Repair Squadrons,” Sep 1965, AHO.

533 Ibid.

534 Department of the Air Force, Headquarters U.S. Air Force, AFOMO 457n, Subject: Activation of the 554th and 555th Civil Engineering Squadrons (Heavy Repair). 1 October 1965.

535 Maj. Gen. R. H. Curtin, “The Director Says…Prime BEEF Teams…’Excellent’,” *AFCE,* Vol 7, No 1, February 1966, 1.

536 Brig. Gen. William T. Meredith, (USAF, Retired), “Oral History Interview,” Interviewed by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, 2001, 63; Brig. Gen. Archie S. Mayes, “Oral History Interview,”

Interviewed by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, 2000, 168.

537 "Dedication of BCEC Class 66B To "RED HORSE"," *Force Civil Engineer,* Vol 7, No 2, May 1966. 7.

538 Maj. Gen. Robert H. Curtin, (USAF, Retired), "Oral History Interview," Interviewed by Lois E. Walker and Dr. Ronald B. Hartzer, HQ AFCESA, Tyndall AFB, Florida, 2003, 41.

539 Brig. Gen. William T. Meredith, (USAF, Retired), "Oral History Interview," Interviewed by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, 2001, 64. The exact definition of the RED HORSE acronym has experienced numerous permutations over the years. Air Force Regulation 85-25, Project RED HORSE, that formally established the RED HORSE program, defined it as Rapid Engineer Deployable Heavy Operations Repair Squadrons, Engineer. A 1966 article in the Air Force Civil Engineer Magazine that introduced the concept to the career field identified it as Rapid Engineer Deployment, Heavy Operational Repair Squadrons, Engineering. Air Force Regulation 93-9 offered another alternative in 1983, Rapid Engineer Deployable, Heavy Operational Repair Squadron, Engineer. Finally, in 1988, RED HORSE was adopted as an approved nickname and no longer had to be identified as an acronym. In June 2011, Maj. Gen. Timothy A. Byers, The Air Force Civil Engineer, reaffirmed this change and approved the use of RED HORSE as a nickname.

540 Brig. Gen. Archie S. Mayes, "Oral History Interview," Interviewed by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, 2000, 66.

541 Brig. Gen. William T. Meredith, (USAF, Retired), "Oral History Interview," Interviewed by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, 2001, 64, 68-69, 202; Brig. Gen. Archie S. Mayes, "Oral History Interview," Interviewed by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, 2000, 168.

542 Brig. Gen. William T. Meredith, (USAF, Retired), "Oral History Interview," Interviewed by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, 2001, 64-67.

543 Ibid., 65.

544 Ibid., 67.

545 Ibid., 68.

546 Project RED HORSE," *AFCE*, Vol 7, No 2, May 1966, 2-4.

547 Brig. Gen. William T. Meredith, (USAF, Retired), "Oral History Interview," Interviewed by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, 2001, 63, *appendix F*, 205.

548 Maj. Gen. Robert H. Curtin, (USAF, Retired), "Oral History Interview," Interviewed by Lois E. Walker and Dr. Ronald B. Hartzer, HQ AFCESA, Tyndall AFB, Florida, 2003, 41.

549 Brig. Gen. Archie S. Mayes, (USAF, Retired), "Oral History Interview," Interviewed by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, 2000, 61.

550 Ibid., 89.

551 Ibid., 168-169.

552 Ibid., 89.

553 Quoted in Jean Martin, SSgt. Douglas W. Stephens, SSgt. Robert F. Jakob, *USAF Airfield Construction in South Vietnam July 1965 – March 1967*, Vol I, 101, Historical Division Directorate of Information, HQ 7th AF, no date, AHO.

554 Department of the Air Force Staff Summary Sheet, Subject: Additional Air Force Civil Engineering Squadrons (Heavy Repair), 8 June 1966, AHO.

555 Jean Martin, SSgt. Douglas W. Stephens, SSgt. Robert F. Jakob, *USAF Airfield Construction in South Vietnam July 1965 – March 1967*, Vol I, 104, Historical Division Directorate of Information, HQ 7th AF, no date, AHO.

556 Capt. David D. Currin, "Major Construction Projects-A RED HORSE Reality," *AFCE*, Vol 9, No 1, February 1968, 32-33.

557 Brig. Gen. Archie S. Mayes, (USAF, Retired), "Oral History Interview," Interviewed by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, 2000, 68-70.

558 Ibid., Appendix E "End of Tour Report HQ Seventh Air Force Directorate of Civil Engineering," 129.

559 Col. George A. Bohlen, "Research Report No. 9, USAF Engineer Heavy Repair/Troop Construction Capability," A Research Report Submitted to the Faculty, Air War College, Air University, USAF, Maxwell AFB, Alabama, 25 May 1977, 17.

560 "RED HORSE and the Civil Engineering Field Activities Center," *AFCE*, Vol 8, No 4, November 1967, 2-4.

561 George K. Dimitroff, "Training With RED HORSE," *AFCE*, Vol 8, No 4, November 1967, 5-7.

562 Lt. Col. Francis E Torr, "Air Operations in Vietnam, The AF Civil Engineer's Role in Counterinsurgency" *AFCE*, Vol 6, No 3, August 1965, 2.

563 Historical Brochure of SEA Engineering Development 1961-1964, prepared by DCES, AFCESA Tyndall AFB, Florida, 62-63.

564 1st Lt. John G. Terino, "Vietnam Report No. 2 Prime BEEF Team No. 2," *AFCE*, Vol 7, No 2, May 1966, 4.

565 Col. I.H. Impson, "Southeast Asia 1962," *AFCE*, Vol 4, No 1, February 1963, 2-6.

566 USAF Logistics Activities in Support Operations On Southeast Asia, 1 January 1965-31 December 1969, 156, Project Corona Harvest, Air Force Historical Research Agency, Maxwell AFB, Alabama.

567 USAF Logistics Activities in Support Operations On Southeast Asia, 1 January 1965-31 December

1969, 152, Project Corona Harvest, Air Force Historical Research Agency, Maxwell AFB, Alabama; Edward F.C. Lau, "The Base Civil Engineer and Environmental Engineering Control in Southeast Asia," *AFCE*, Vol 9 No 4, November 1968, 10-12.

568 "Vietnam Report No 3, Air Force Engineering Projects at Bien Hoa Top $9 Million Mark," *AFCE,* Vol 7, No 3, August 1966, 22-23.

569 "Pleiku Civil Engineers have 20-Fold Construction Increase," *AFCE*, Vol 7, No 4, November 1966, 23.

570 "History of 823d Civil Engineering Squadron (HR), 1 July 66 – 30 June 67," 46, AHO.

571 Waggoner & Moe, 219; Steve Canton, "This Air Force Colonel Wears Four Hats," *AFCE,* Vol 8, No 1, 1967, 2-7.

572 Capt. David M. De Blonk and Col. Robert G. Gardner, "A HQ USAF Directorate of Civil Engineering (AFOCE) Activity Input to Project Corona Harvest on Civil Engineering Support in SEA 1 January 1965 – 31 March 1968," Submitted 18 December 1969 by the USAF Civil Engineering Center, 278; 369.

573 Waggoner & Moe, 219-220.

574 Capt. David M. De Blonk and Col. Robert G. Gardner, "A HQ USAF Directorate of Civil Engineering (AFOCE) Activity Input to Project Corona Harvest on Civil Engineering Support in SEA 1 January 1965 – 31 March 1968," Submitted 18 December 1969 by the USAF Civil Engineering Center, 279.

575 Lt. Col. Donald R. Woods, "Turn Key Status Report," *AFCE*, Vol 8, No 3, August 1967, 11.

576 Capt. David M. De Blonk and Col. Robert G. Gardner, "A HQ USAF Directorate of Civil Engineering (AFOCE) Activity Input to Project Corona Harvest on Civil Engineering Support in SEA 1 January 1965 – 31 March 1968," Submitted 18 December 1969 by the USAF Civil Engineering Center, 280-1.

577 Ibid., 281.

578 James J. Claps, " The Air Force Modular Relocatable Facilities Program," *AFCE*, Vol 10, No 4, November 1970,14-15

579 Col. Winston H. Clisham, " Relocatable Concept Validated," *AFCE*, Vol 11, No 3, August 1970, 8-9.

580 George R. Taylor and John F. Heise, "How AFLC Civil Engineers Back Up the Troops in Southeast Asia," *AFCE*, Vol 8, No 1, February 1967, 24.

581 Waggoner & Moe, 238.

582 Engineering Lessons Learned in Southeast Asia 1964-1969, PACAF Civil Engineering, Preliminary Report June 12 1969, AHO.

583 Capt. David M. De Blonk and Col. Robert G. Gardner, "A HQ USAF Directorate of Civil Engineering (AFOCE) Activity Input to Project Corona Harvest on Civil Engineering Support in SEA 1 January 1965 – 31 March 1968," Submitted 18 December 1969 by the USAF Civil Engineering Center, 59.

584 USAF Logistics Activities in Support Operations On Southeast Asia, 1 January 1965-31 December 1969, 171-172, Project Corona Harvest, Air Force Historical Research Agency, Maxwell AFB, Alabama.

585 Waggoner & Moe, 234; USAF Logistics Activities in Support Operations On Southeast Asia, 1 January 1965-31 December 1969, 169, Project Corona Harvest, Air Force Historical Research Agency, Maxwell AFB, Alabama.

586 Waggoner & Moe, 235.

587 Capt. David M. De Blonk and Col. Robert G. Gardner, "A HQ USAF Directorate of Civil Engineering (AFOCE) Activity Input to Project Corona Harvest on Civil Engineering Support in SEA 1 January 1965 – 31 March 1968," Submitted 18 December 1969 by the USAF Civil Engineering Center, 269-270.

588 E.T. Lyons, "Aluminum Matting Runways in Vietnam," *TME*, Vol 58, No 384, July-August 1966, 245.

589 Major Donald A. Haas, "Phan Rang Air Base," *TME*, Vol 58, No 386, November-December 1966, 433.

590 E.T. Lyons, "Aluminum Matting Runways in Vietnam," *TME*, Vol 58 No 384, July-August 1966, 246.

591 "Directorate of Civil Engineering U.S. Air Force" *TME*, Vol 58, No 382, March-April 1966, 126.

592 Capt. David M. De Blonk and Col. Robert G. Gardner, "A HQ USAF Directorate of Civil Engineering (AFOCE) Activity Input to Project Corona Harvest on Civil Engineering Support in SEA 1 January 1965 – 31 March 1968," Submitted 18 December 1969 by the USAF Civil Engineering Center, 265.

593 Lt. Col. Maynard G. Hamilton, "Base Operation and Maintenance, SEA" *AFCE*, Vol 9, No 2, May 1968, 14-15.

594 Lt. Col. Francis E. Torr, "Air Operations in Vietnam, The Air Force Civil Engineers Role in Counter-insurgency" *AFCE*, Vol 6, No 3, August 1965, 2-6.

595 Edward F.C. Lau, "The Base Civil Engineer and Environmental Engineering Control in Southeast Asia," *AFCE*, Vol 9 No 4, November 1968, 10-12.

596 Lt. Col. Francis E. Torr, "Air Operations in Vietnam, The Air Force Civil Engineers Role in Counter-insurgency" *AFCE*, Vol 6, No 3, August 1965, 2-6.

597 USAF Logistics Activities in Support Operations On Southeast Asia, 1 January 1965-31 December 1969, 173-175, Project Corona Harvest, Air Force Historical Research Agency, Maxwell AFB, Alabama.

598 Waggoner & Moe, 221.

599 MSgt George J. Frank, "Bien Hoa Holocaust," *Aerospace Historian*, No. 27 September 1980, 195-198.

600 Capt. David M. De Blonk and Col. Robert G. Gardner, "A HQ USAF Directorate of Civil Engineering (AFOCE) Activity Input to Project Corona Harvest on Civil Engineering Support in SEA 1 January 1965 – 31 March 1968," Submitted 18 December 1969 by the USAF Civil Engineering Center, 170.

601 Waggoner & Moe, 220; 223; Col. Kaufman, Lt. Col. Torr, Maj. Fearn, Capt. Bratton, "Vietnam Report Prime BEEF in Action", *AFCE*, Vol 7, No 1, February 1966, 5; Prime BEEF Team #1 Historical Report, 6 Aug – 2 Dec 1965, AHO.

602 "Da Nang Slab Revetments," *AFCE*, Vol 11, No 4, November 1970, 30.

603 Brig. Gen. William T. Meredith, (USAF, Retired), "Oral History Interview," Interviewed by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, 2001, 79.

604 USAF Logistics Activities in Support of Operations in Southeast Asia 1 January 1965 – 31 December 1969, 170, AHO.

605 Capt. David M. De Blonk and Col. Robert G. Gardner, HQ USAF Directorate of Civil Engineering (AFOCE) Activity Input to Project Corona Harvest on Civil Engineering Support in SEA 1 January 1965 – 31 March 1968, USAF Civil Engineering Center, 18 December 1969, 27.

606 Col. Lindsey M. Silvester, USAF Director of Tactical Evaluation DCS/Operations; Letter of Transmittal PACAF CORONA HARVEST Studies, 23 October 1970, 1.

607 SMSgt. Earl L. Walsh, "Fire Protection for Vietnam," *AFCE* August 1967, 32-33.

608 Ibid.

609 Ibid.

610 Douglas E. Courchene, *Pioneers with Intent, Memoirs of an Air Force Fire Fighter*, Air Force Civil Engineer Support Agency, Tyndall AFB, July 2003, 78; Capt. Joe G. Ballard, An Organizational History of Air Force Fire Protection, Synopsis of AFIT Thesis from the AHO, 28.

611 USAF Logistics Activities in Support Operations On Southeast Asia, 1 January 1965-31 December 1969, 168, Project Corona Harvest, Air Force Historical Research Agency, Maxwell AFB, Alabama; "Feasibility Study for Tuy Hoa Air Base, Republic of Vietnam," Adrian Wilson and Assoc., 4 Oct 1965; "Feasibility Study for Phan Rang Air Base, Republic of Vietnam," Adrian Wilson and Assoc., 9 Sep 1965; "Feasibility Study for Phu Cat (Qui Nhon) Air Base, Republic of Vietnam," Adrian Wilson and Assoc., 14 Apr 1966, AHO.

612 Capt. David M. De Blonk and Col. Robert G. Gardner, "A HQ USAF Directorate of Civil Engineering (AFOCE) Activity Input to Project Corona Harvest on Civil Engineering Support in SEA 1 January 1965 – 31 March 1968," Submitted 18 December 1969 by the USAF Civil Engineering Center, 5-6; 13.

613 Lt. Col. Floyd A. Ashdown, "A History of the Warfighting Capability of Air Force Civil Engineering," Research Report, Air War College Air University Maxwell Air Force Base, Alabama May 1984, 56; Capt. David M. De Blonk and Col. Robert G. Gardner, "A HQ USAF Directorate of Civil Engineering (AFOCE) Activity Input to Project Corona Harvest on Civil Engineering Support in SEA 1 January 1965 – 31 March 1968," Submitted 18 December 1969 by the USAF Civil Engineering Center, 116.

614 Lt. Col. Floyd A. Ashdown, "A History of the Warfighting Capability of Air Force Civil Engineering," Research Report, Air War College Air University Maxwell Air Force Base, Alabama May 1984, 57.

615 Maj. Donald A. Haas, "Phan Rang Air Base," *TME*, Vol 58, No 386 November-December 1966, 431.

616 E.T. Lyons, "Aluminum Matting Runways in Vietnam," *TME*, Vol 58, No 384, July-August 1966, 246.

617 Jean Martin, SSgt. Douglas W. Stephens, SSgt. Robert F. Jakob, *USAF Airfield Construction in South Vietnam July 1965 – March 1967*, Vol I, 30-39, Historical Division Directorate of Information, HQ 7th AF, no date, AHO.

618 Maj. Gen. Guy H. Goddard, (USAF, Retired), "Oral History Interview," Interviewed by Dr. Ronald B. Hartzer and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, February 2003, 10.

619 Waggoner & Moe, 245.

620 Lois E. Walker, "A Tradition of Excellence," *The CE*, Vol 7, No 4, Winter 1999-2000, 28-29.

621 USAF Logistics Activities in Support Operations On Southeast Asia, 1 January 1965-31 December 1969, 160, Project Corona Harvest, Air Force Historical Research Agency, Maxwell AFB, Alabama.

622 Brig. Gen. Archie Mayes, (USAF, Retired), "Oral History Interview," Interviewed by Dr. Ronald B. Hartzer, HQ AFCESA, Tyndall AFB, Florida, June 2001, Appendix B.

623 USAF Logistics Activities in Support Operations On Southeast Asia, 1 January 1965-31 December 1969, 160, Project Corona Harvest, Air Force Historical Research Agency, Maxwell AFB, Alabama.

624 Lt. Col. Floyd A. Ashdown, "A History of the Warfighting Capability of Air Force Civil Engineering," Research Report, Air War College Air University Maxwell Air Force Base, Alabama May 1984,61.

625 Steve Canton, "Operation Turn Key," *The Civil Engineer* November 1966, 4; Maj. Gen. Robert H. Curtin, "Turn Key Project at Tuy Hoa," *TME*, Vol 59, No 389, May-June 1967, 163; Lt. Col. Floyd A. Ashdown, "A History of the Warfighting Capability of Air Force Civil Engineering," Research Report, Air War College Air University Maxwell Air Force Base, Alabama May 1984, 60.

626 "Meet Col. David S. Chamberlain, PE," *AFCE*, Vol 8 No 4, November 1967, 13.

627 Brig. Gen. Archie Mayes, (USAF, Retired), "Oral History Interview," Interviewed by Dr. Ron Hartzer, HQ AFCESA, Tyndall AFB, Florida, June 2001, Appendix B; Waggoner & Moe, 245.

628 Waggoner & Moe, 246.

629 Steve Canton, "Operation Turn Key" *AFCE*, Vol 7, No 4, November 1966, 2.

630 Major Jeffrey L. Tyley, *Project Turnkey Construction of Tuy Hoa Air Base, South Vietnam – A Historical Perspective – Is There Future Application?* Air Command and Staff College, Air University April 1987, 6-7.

631 Ibid., 17.

632 Brig. Gen. Archie Mayes, (USAF, Retired), "Oral History Interview," Interviewed by Dr. Ronald B. Hartzer, HQ AFCESA, Tyndall AFB, Florida, June 2001, Apendix B.

633 Brig. Gen. John D. Peters, (USAF, Retired), "Oral History Interview," Interviewed by Dr. Ronald B. Hartzer and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, June 2001, 34-35.

634 Brig. Gen. Archie Mayes, (USAF, Retired),"Oral History Interview," Interviewed by Dr. Ronald B. Hartzer, HQ AFCESA, Tyndall AFB, Florida, June 2001, 73.

635 Brig. Gen. John D. Peters, (USAF, Retired), "Oral History Interview," Interviewed by Dr. Ronald B. Hartzer and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, June 2001, 34.

636 Mr. Gary S. Flora, (SES, Retired), "Oral History Interview," Interviewed by Lois E. Walker and Dr. Douglas H. Merkle, HQ AFCESA, Tyndall AFB, Florida, September 2005,14.

637 Major Jeffrey L. Tyley, *Project Turnkey Construction of Tuy Hoa Air Base, South Vietnam – A Historical Perspective – Is There Future Application,* Air Command and Staff College, Air University, April 1987,13-15.

638 Jean Martin, SSgt. Douglas W. Stephens, SSgt. Robert F. Jakob, *USAF Airfield Construction in South Vietnam July 1965 – March 1967*, Vol I, 90-91, Historical Division Directorate of Information, HQ 7th AF, no date, AHO; Maj. Gen. Robert H. Curtin, "Turn Key Project at Tuy Hoa," *TME*, Vol 59, No 389, May-June 1967, 160.

639 Brig. Gen. Archie Mayes, (USAF, Retired), "Oral History Interview," Interviewed by Dr. Ronald B. Hartzer, HQ AFCESA, Tyndall AFB, Florida, June 2001,75.

640 Brig. Gen. John D. Peters, (USAF, Retired), "Oral History Interview," Interviewed by Dr. Ronald B. Hartzer and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, June 2001, 33.

641 Brig. Gen. Archie Mayes, (USAF, Retired),"Oral History Interview," Interviewed by Dr. Ronald B. Hartzer, HQ AFCESA, Tyndall AFB, Florida, June 2001, 83.

642 Lt. Col. Donald R. Woods, "Turn Key Status Report," *AFCE*, Vol 8, No 3, August 1967, 11.

643 Mr. Gary S. Flora, (SES, Retired), "Oral History Interview," Interviewed by Lois E. Walker and Dr. Douglas H. Merkle, HQ AFCESA, Tyndall AFB, Florida, September 2005,16

644 Brig. Gen. Archie Mayes, (USAF, Retired),"Oral History Interview," Interviewed by Dr. Ronald B. Hartzer, HQ AFCESA, Tyndall AFB, Florida, June 2001, 83.

645 Brig. Gen. John D. Peters, (USAF, Retired), "Oral History Interview," Interviewed by Dr. Ronald B. Hartzer and Lois E. Walker, Air Force Civil Engineering Support Agency, Tyndall AFB, Florida, June 2001, 33.

646 Maj. Jeffrey L. Tyley, *Project Turnkey Construction of Tuy Hoa Air Base, South Vietnam – A Historical Perspective – Is There Future Application?,* Air Command and Staff College, Air University, April 1987,13-15; Jean Martin, SSgt. Douglas W. Stephens, SSgt. Robert F. Jakob, *USAF Airfield Construction in South Vietnam July 1965 – March 1967*, Vol I, 94, Historical Division Directorate of Information, HQ 7th AF, no date; Herman S. Wolk, "USAF Plans and Policies, Logistics and Base Construction in Southeast Asia, 1967," USAF Historical Division Liaison Office, October 1968, 30, AHO.

647 Brig. Gen. Archie Mayes, (USAF, Retired), "Oral History Interview," Interviewed by Dr. Ronald B. Hartzer, HQ AFCESA, Tyndall AFB, Florida, June 2001, 83.

648 Maj. Jeffrey L. Tyley, *Project Turnkey Construction of Tuy Hoa Air Base, South Vietnam – A Historical Perspective – Is There Future Application?,* Air Command and Staff College, Air University, April 1987,13-15; Jean Martin, SSgt. Douglas W. Stephens, SSgt. Robert F. Jakob, *USAF Airfield Construction in South Vietnam July 1965 – March 1967*, Historical Division Directorate of Information, HQ 7th AF, no date.

649 Brig. Gen. John D. Peters, (USAF, Retired), "Oral History Interview," Interviewed by Dr. Ronald B. Hartzer and Lois E. Walker, Air Force Civil Engineering Support Agency, Tyndall AFB, Florida, June 2001, 35; Waggoner & Moe, 248.

650 Brig. Gen. Archie Mayes, (USAF, Retired), "Oral History Interview," Interviewed by Dr. Ronald B. Hartzer, HQ AFCESA, Tyndall AFB, Florida, June 2001, 70.

651 Ibid., Appendix B; Maj.Allan D. Aikens, *History of the 820th Civil Engineering Squadron (Heavy Repair), Jan-Mar 1967*, AHO.

652 Lt. Col. Floyd A. Ashdown, "A History of the Warfighting Capability of Air Force Civil Engineering," Research Report, Air War College Air University Maxwell Air Force Base, Alabama May 1984, 58.

653 Lois E. Walker, "A RED HORSE Roundup," *The CE*, Vol 8, No 3, Fall 2000, 28-30.

654 Col. F.A. DeMartino, "Mailbox," *The CE*, Vol 5, No 3, Fall 2000, 11.

655 Mr. Gary S. Flora, (SES, Retired), "Oral History Interview," Interviewed by Lois E. Walker and Dr. Douglas H. Merkle, HQ AFCESA, Tyndall AFB, Florida, September 2005, 16.

656 Maj. Gen. Guy H. Goddard, (USAF, Retired), "Oral History Interview," Interviewed by Dr. Ronald B. Hartzer and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, February 2003, 12.

657 "Meet Col. David S. Chamberlain, PE," *AFCE*, Vol 8 No 4, November 1967, 13.

658 Brig. Gen. Archie S. Mayes (USAF, Retired), Oral Interview with Dr. Ronald B. Hartzer, 1988, 5.

659 Capt Juventino R. Garcia, *History of the 6175th Air Base Group, Kunsan AB, Korea, 1 Jan-31 Mar 1968*, AHO.

660 Ibid., June 2001, 94-95.

661 William D. Middleton, "Military Construction in Korea," *TME*, Vol 64, No 417, January-February 1972, 30-32; "Operation Combat Fox," *AFCE*, Vol 10, No 3, August 1969, 2-6.

662 Air Staff History, January-December 1968, n.p., AHO.

663 Memo, Brig. Gen. Archie S. Mayes to Col. W. H. Clisham, 29 May 1969, included in *557th Yearbook, Sep 68-Oct 69*, AHO.

664 William D. Middleton, "Military Construction in Korea," *TME*, Vol 64, No 417, January-February 1972, 30-32; "Operation Combat Fox," *AFCE*, Vol 10, No 3, August 1969, 2-6.

665 Maj. Gen. Robert H. Curtin, (USAF, Retired), "Oral History Interview," Interviewed by Lois E. Walker and Dr. Ronald B. Hartzer, HQ AFCESA, Tyndall AFB, Florida, 2003, 45-46.

666 Waggoner & Moe, 204; George Brown Tindall and David E. Shi, *America, A Narrative History.* W.W. Norton and Company, New York, New York, 1992, 1387.

667 R.R. Palmer and Joel Colton, *A History of the Modern World*, Alfred A. Knopf, New York, New York, 1978, 923.

668 John Schlicht, *A War Too Long: The USAF in Southeast Asia 1961-1975*, Air Force History and Museums Program, 1996, 101, 103-106.

669 Brig. Gen. William T. Meredith, (USAF, Retired), "Oral History Interview," Interviewed by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, 2001, 102-104.

670 Maj. Gen. William D. Gilbert, (USAF, Retired), "Oral History Interview," Interviewed by Lois E. Walker, AFCESA, Tyndall AFB, Florida, September 2002, 53-55; Lt. Col. Floyd A. Ashdown, "A History of the Warfighting Capability of Air Force Civil Engineering," Research Report, Air War College, Air University, Maxwell Air Force Base, Alabama May 1984, 66.

671 Lt. Charles B. Prior, "History of the 554th Civil Engineering Squadron Heavy Repair, July-September 1974,"; Lt. Charles B. Prior, "History of the 554th Civil Engineering Squadron Heavy Repair, Oct-Dec 1974;" Air Force Historical Research Agency, "Lineage and Honors History of the 554th RED HORSE Squadron," 29 Feb 2000.

672 Maj. Gen. William D. Gilbert, (USAF, Retired), "Oral History Interview," Interviewed by Lois E. Walker, AFCESA, Tyndall AFB, Florida, September 2002, 54.

673 Capt. John M. Ledden, "What Is Corona Harvest?," *AFCE*, Vol 9, No 2, May 1968, 33.

674 Bare Base Development Program Project 3782, Corona Harvest, 24 January 1969, 1.

675 Ibid., 7.

676 Ibid., 2.

677 Ibid., 7.

678 Ibid., 2.

679 Ibid., 7.

680 Ibid., 7.

681 U.S. Air Force/Fact Sheet, Bare Base Concept 70-4, 2.

682 Ibid., 1.

683 Bare Base Mobility, Project 3782, 7-8.

684 U.S. Air Force/Fact Sheet, Bare Base Concept 70-4, 3.

685 Ibid.

686 Quoted in "A Pacific Air Forces Activity Input to Project Corona Havest on In-Country and Out-Country Strike Operations in Southeast Asia, Vol IV-Support, Civil Engineers, 1 April 1968 – 31 December 1969, 19, AHO.

687 Brig. Gen. William T. Meredith, (USAF, Retired), "Oral History Interview," Interviewed by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, 2001, 107.

688 Maj. John L. Moore, "How to Employ RED HORSE in the CONUS," Air Force Civil Engineer, Vol 13, No 3, August 1972, 1-5, 13.

689 Ibid.

690 John A. McAndrews, editor, *Air Force Contribution to U.S. Public Works*, Study No. 143, 1974, 91, on file at Maxwell Air Force Base, Alabama.

691 Ibid.

692 Francis A. Sanders, "Air Force Engineers in Civic Actions," *TME*, Vol 57, No 378, July-August 1965, 246.

693 Ibid.

694 Col. Francis A. Sanders, "Air Force Civil Engineers in…Community Relations," *AFCE*, Vol 7, No 3, August 1966, 6-7.

695 Brig. Gen. William T. Meredith, (USAF, Retired), "Oral History Interview," Interviewed by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, 2001, 86.

696 Dr. Ronald B. Hartzer, "Oh! For a Horse with Wings," U.S. Air Force Civil Engineer, Vol 1, No 6, August 1993, 7.

697 Max W. Day, "Civic Action: A New Role for Prime BEEF," *TME,* Vol 64, No 418, March-April 1972, 109; Capt. Marcus B. Moses, "A New Kind of Air Force Civil Engineer," *AFCE*, Vol 12, No 3, August 1971, 16-18.

698 Air Staff History, January-June 1970, n.p., AHO.

699 Max W. Day, "Civic Action: A New Role for Prime BEEF," *TME,* Vol 64, No 418, March-April 1972, 109; Capt. Marcus B. Moses, "A New Kind of Air Force Civil Engineer," *AFCE*, Vol 12, No 3, August 1971, 16-18.

700 Capt. Marcus B. Moses, "A New Kind of Air Force Civil Engineer," *AFCE*, Vol 12, No 3, August 1971, 16-18.

701 Max W. Day. "Civic Action: A New Role for Prime BEEF," *TME,* Vol 64, No 418, March-April 1972, 109; Capt. Marcus B. Moses, "A New Kind of Air Force Civil Engineer," *AFCE*, Vol 12, No 3, August 1971, 16-18.

702 Max W. Day, "Civic Action: A New Role for Prime BEEF," *TME,* Vol 64, No 418, March-April 1972, 108-109; Air Staff History, January-June 1972, n.p., AHO.

703 Air Staff History, January-June 1973, n.p., AHO.

704 Maj. Gen. William D. Gilbert, (USAF, Retired), "Oral History Interview," Interviewed by Lois E. Walker, AFCESA, Tyndall AFB, Florida, September 2002, v, 55-56; "Four Related First-hand Accounts of the Vietnam Refugee Operations in the Pacific," Col. Donald Kane, USAF Ret, Nov 2013, AHO.

705 Maj. P.A. Peckham, Capt. P.G. Arnold, and Capt. J.L. Davis, "Transition to a New Life," *Air Force Engineering & Services Quarterly*, Vol 16, No 3, August 1975, 13-17.

706 Ibid.

707 Ibid.

708 Kenneth T. Sawyer, "The Alaska Earthquake, Effects, Reaction, and Recovery," *TME*, Vol 56, No 372, July-August 1964, 247.

709 James R. Powers, "An Engineering Glimpse of The Alaskan Earthquake," *AFCE*, Vol 6, No 1, February 1965, 4.

710 Kenneth T. Sawyer, "The Alaska Earthquake, Effects, Reaction, and Recovery," *TME*, Vol 56, No 372, July-August 1964, 247.

711 Directorate of Civil Engineering U.S. Air Force, *TME*, Vol 57, No 377, May-June 1965, 204.

712 Capt. Joseph A. Ahearn, "A Prime BEEF Team in Action," *AFCE*, Vol 7, No 3, August 1966, 18-19.

713 Thomas Sweat and CMSgt. Carl L. Keatts, "Project Prime BEEF-Its Value in Natural Disasters," *AFCE*, Vol 9, No 1, February 1968, 28-29; Thomas Sweat and CMSgt. Carl L. Keatts, "Prime BEEF and the Alaska Flood," *TME*, Vol 60, No 393, January-February 1968, 26-27.

714 Directorate of CE (DCS/P&R), Air Staff History, January-June 1967, n.p., AHO.

715 Lucille T. Garrett and Edward Sanchez, "Camille and the Engineers," *TME*, Vol 61, No 404, November-December 1969, 407-409.

716 William B. Musick "Hurricane Camille: Prime BEEF Tested Again," *AFCE*, Vol 11, No 1, February 1970, 17.

717 Edward M. Smith, "They Stayed Until the Job was Done – Hurricane Agnes," Air *Force Civil Engineer*, Vol 14, No 1, February 1973, 4-7.

718 Ibid., 6-7.

719 Edward E. Vigee, "Engineers Help a Community Recover," *AFCE*, Vol 14, No 1, February 1973, 8-10.

720 Robert J. Adamcik, "Tornado Cleanup," *TME*, Vol 66, No 432, July-August 1974, 225-7.

721 "Xenia Tornado Disaster, Civil Engineers Lend a Helping Hand," *AFCE*, Vol 15, No 3, August 1974, 28-29.

722 Maj. Gen. M.R. Reilly, "Air Force Civil Engineering, What's Ahead?" *TME*, Vol 66, No 429, January-February 1974, 10.

723 Ibid.

724 Ibid., 10-12.

725 Ibid.

726 Maj. Gen. Billie G. McGarvey, "In Retrospect-An Open Letter from the Departing Director," *AFCE*, Vol 16, No 2, May 1975, 7.

Chapter 4 Endnotes

1 Maj. Gen. M.R. Reilly, "Air Force Civil Engineering, What's Ahead?" *The Military Engineer* [hereafter cited as *TME*], Vol 66, No 429, January-February 1974, 10.

2 Air Staff History 1 January through 30 June 1976, np, Files of AFCEC History Office, Tyndall AFB, Florida [hereafter cited as AHO].

3 Brig. Gen. Robert C. Thompson, "On Breaking With Tradition," *Air Force Civil Engineer* [hereafter cited as *AFCE*], Vol 16, No 2, May 1975, 1.

4 Charles Joseph Gross, *The Air National Guard and the American Military Tradition*, Historical Services Division, National Guard Bureau, Washington, D.C., 1995, 114.

5 Maj. Gen. M.R. Reilly, "Air Force Civil Engineering, What's Ahead?" *TME*, Vol 66, No 429, January-February 1974, 10; Brig. Gen. Bernard C. Meredith, PE, "What's New in Programming," *Air Force Engineering & Services Quarterly* [hereafter cited as *ESQ*], Vol 18, No 1, February 1977, 36.

6 Brig. Gen. Bernard C. Meredith, PE, "What's New in Programming," *ESQ*, Vol 18, No 1, February 1977, 34-37.

7 Walton S. Moody and Jacob Neufeld, "Carrying Out National Policy," *Winged Shield, Winged Sword, A History of the United States Air Force, Vol II,* Government Printing Office, 1997, Washington DC, 373-402; Maj. Gen. William D. Gilbert, "Air Force Engineering Meeting Global Challenges," *TME,* Vol 73, No 471, January-February 1981, 10.

8 Maj. Gen. William D. Gilbert, "Air Force Engineering Meeting Global Challenges," *TME,* Vol 73, No 471, January-February 1981, 10.

9 Walton S. Moody and Jacob Neufeld, "Carrying Out National Policy," *Winged Shield, Winged Sword, A History of the United States Air Force, Vol II,* Government Printing Office, 1997, Washington DC, 373-402; U.S. Army Environmental Center, Thematic Study and Guidelines: Identification and Evaluation of U.S. Army Cold War Era Military-Industrial Historic Properties, 1997, 53-55.

10 Capt. Dean Fox, "Air Force 2000," *ESQ*, Vol 23, No 4, Winter 1982-1983, 4.

11 Maj. Gen. William D. Gilbert, "Air Force Engineering Meeting Global Challenges," *TME,* Vol 73, No 471, January-February 1981, 10.

12 "Prime BEEF Combat Support Team Implementation Guidance," HQ AFESC/DEO, 1 Nov 1986, AHO; Lt. Col. O.F. Smith, EIT, "Our Ability to Fly and Fight: A Matter of Readiness," *ESQ*, Vol 18, No 4, November 1977, 3-7.

13 Col. Darrell G. Bittle, "Air Base Survivability," *ESQ*, Vol 23, No 1, Spring 1982, 7-13.

14 Directorate of Engineering and Services Current Emphasis," *ESQ*, Vol 18, No 3, August 1977, 11.

15 Maj. Gen. William D. Gilbert (USAF, Retired), "Oral History Interview," interview by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, September 2002, 69.

16 Brig. Gen. Bernard C. Meredith, PE, "What's New in Programming," *ESQ*, Vol 18, No 1, February 1977, 34-37.

17 Arthur B. Markowitz, "The 'Forum'," *ESQ*, Vol 26, No 3, Fall 1985, 28.

18 Col. Harry Glaze, "Keep off the Grass," *ESQ*, Vol 27, No 2, Summer 1986, 4-5.

19 "Air Force Engineering and Services Agency," *TME,* Vol 69, No 450, July-August 1977, 267-268.

20 Maj. Gen. William D. Gilbert (USAF, Retired), "Oral History Interview," interview by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, September 2002, 61.

21 Maj. Gen. Clifton D. Wright, Jr. (USAF, Retired), "Oral History Interview," interview by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, May 2002, 48.

22 Ibid. 33-34, 49, 58.

23 Gen. Wilbur L. Creech, "In Dedication…General Creech's Comments: Dedication of the Air Force Engineering and Services Center Building in Memory of Major General Robert C. Thompson, USAF, Tyndall AFB, Florida, July 1, 1982," *ESQ*, Vol 23, No 3, Fall 1982, 24.

24 Lois Walker, "A Tradition of Excellence," *The CE*, Vol 7, No 4, Winter 1999-2000, 31.

25 Maj. Gen. William D. Gilbert, "Decade of the Challenge…the 1980s," *ESQ*, Vol 21, No 1, February 1980, 6.

26 Ibid., 4-5; Maj. Gen. William D. Gilbert, "Needed: Managers, Engineers, Leaders," *ESQ*, Vol 22, No 3, Fall 1981, 4-5.

27 Maj. Gen. William D. Gilbert (USAF, Retired), "Oral History Interview," interview by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, September 2002, iii-v; , 58; Lois Walker, "A Tradition of Excellence," The CE, Vol 7, No 3, Fall 1999, 34.

28 Maj. Gen. Clifton D. Wright, Jr., "Strategy for Tomorrow Moving Forward with a Strategic Plan," *ESQ*, Vol 25, No 1, Spring 1984, 3-6.

29 "Directorate of Engineering and Services Current Emphasis," *ESQ*, Vol 24, No 2, Summer 1983, 23.

30 Maj. Gen. Clifton D. Wright, Jr., "Strategy for Tomorrow Moving Forward with a Strategic Plan," *ESQ*, Vol 25, No 1, Spring 1984, 3-6.

31 Maj. Gen. Clifton D. Wright, Jr. (USAF, Retired), "Oral History Interview," interview by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, May 2002, viii.

32 Ibid., 111.

33 Lois Walker, "A Tradition of Excellence," *The CE*, Vol 7, No 4, Winter 1999-2000, 31.

34 Gen. George E. Ellis, "General Ellis at AFIT: Highlights of his presentation before new CEs at AFIT," *ESQ*, Spring 1986, 3.

35 Ibid.; "4 Keys to Excellence," *Air Force Engineering & Services Center Update*, January 1989, 2.

36 "General Ellis at AFIT: Highlights of his presentation before new CEs at AFIT," *ESQ*, Vol 27, No 1, Spring 1986, 4-6.

37 Maj. Gen. Joseph A. Ahearn (USAF, Retired), "Oral History Interview," interview by Dr. Douglas H. Merkle and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, March 2008, 96, xi.

38 Commander's Page: Maj. Gen. Joseph A. Ahearn, *Air Force Engineering & Services Center Update*, April-May, 1989, 4.

39 Air Staff History, Directorate of Civil Engineering, July-December 1974; Air Staff History, Directorate of Civil Engineering, July-December 1975.

40 Air Staff History, Directorate of Civil Engineering, January-June 1974; January-June 1975.

41 Air Staff History, Directorate of Civil Engineering, January-June 1975.

42 *TME*, Vol 67, No 440, November-December 1975, 363.

43 Maj. Gen. Clifton D. Wright, Jr. (USAF, Retired), "Oral History Interview," interview by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, May 2002, 49, 33-34.

44 Ibid., 58.

45 Maj. Gen. William D. Gilbert (USAF, Retired), "Oral History Interview," interview by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, September 2002, v, 58.

46 Ibid., 57.

47 Ibid., 57-58.

48 Capt. Richard A. Probst and Capt. Thomas T. Taylor, "BAS/A La Carte: A Future in Air Force Feeding?," *ESQ,* Vol 18, No 2, May 1977, 14-15.

49 Capt. David B. White, "Services: Necessary for Survival," *ESQ*, Vol 23, No 1, Spring 1982, 46.

50 Ibid.

51 Lt. Col. Roy G. Kennington, "Services into the 1980s," *ESQ*, Vol 21, No 1, February 1980, 8.

52 Ibid., 7-10.

53 Maj. Gen. William D. Gilbert (USAF, Retired), "Oral History Interview," interview by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, September 2002, 69.

54 Lt. Col. Roy G. Kennington, "Services into the 1980s," *ESQ*, Vol 21, No 1, February 1980, 9.

55 Maj. Gen. William D. Gilbert (USAF, Retired), "Oral History Interview," interview by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, September 2002, 69.

56 Lt. Col. Roy G. Kennington, "Services into the 1980s," *ESQ*, Vol 21, No 1, February 1980, 8-9.

57 Maj. Ronald C. Bunch, "The Traveling Teams of the AFESC," *ESQ*, Vol 20, No 4, November 1979, 12.

58 Lt. Col. George T. Murphy, "BAT TAC's Approach to Billeting Excellence," *ESQ*, Vol 25, No 1, Spring, 1984, 14-15.

59 "Air Force Engineering and Services Agency," *TME,* Vol 69, No 450, July-August 1977, 267-268.

60 Capt. Kathryn Wagner, "Beirut in Retrospect," *ESQ*, Vol 25, No 4, Winter 1984-1985, 14-15.

61 Maj. Gen. Joseph A. Ahearn (USAF, Retired), "Oral History Interview," interview by Dr. Douglas H. Merkle and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, March 2008, 61.

62 AFESA SO G-1, 1 April 1977, Air Force Historical Research Agency, Maxwell AFB, Alabama.

63 "Air Force Engineering and Services Agency," *TME,* Vol 69, No 450, July-August 1977, 267; Lt. Col. Joseph "Bud" Ahearn, and Henry A. Collin, Jr., "Air Force Engineering and Services Agency," *ESQ*, Vol 18, No 2, May 1977, 2 ; Dr. Ronald B. Hartzer, "Civil Engineering's First Super FOA," *AFCE*, Vol 20, No 1, 2012, 24-25.

64 Lt. Col. Joseph "Bud" Ahearn, and Henry A. Collin, Jr., "Air Force Engineering and Services Agency," *ESQ*, Vol 18, No 3, May 1977, 2.

65 Rudy Anthony and Capt. Kenneth G. Marx, "History of the Air Force Engineering & Services Agency (AFESA), 1 Jan-31 Dec 1977, 102.

66 "Air Force Engineering and Services Agency," *TME,* Vol 69, No 450, July-August 1977, 267-268.

67 Maj. Gen. Clifton D. Wright, Jr. (USAF, Retired), "Oral History Interview," interview by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, May 2002, 61.

68 DAF/PRM to AFESC, Subj: HQ Air Force Civil Engineering and Services Center, a Separate Operating Agency, Memo, 21 June 1978.

69 Maj. Gen. William D. Gilbert (USAF, Retired), "Oral History Interview," interview by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, September 2002, v.

70 Ibid., 66-67.

71 Maj. Gen. Clifton D. Wright, Jr. (USAF, Retired), "Oral History Interview," interview by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, May 2002, 61-62.

72 Ibid., v-viii.

73 George K. Dimitroff, "Air Force Engineering and Services Center: A New Focal Point for Worldwide Activities," *ESQ*, Vol 19, No 4, November 1978, 19; Department of the Air Force to AFESC, Letter, "HQ Air Force Engineering and Services Center, a Separate Operating Agency, 21 June 1978.

74 George K. Dimitroff, "Air Force Engineering and Services Center: A New Focal Point for Worldwide Activities," *ESQ*, Vol 19, No 4, November 1978, 19-20.

75 CMSgt. Larry L. Testerman, compiler, History of the Air Force Engineering and Services Center, 1 January 1978 – 31 December 1978, Vol 1, 1979, 5.

76 George K. Dimitroff, "Air Force Engineering and Services Center: A New Focal Point for Worldwide Activities," *ESQ*, Vol 19, No 4, November 1978, 19-20.

77 CMSgt. Larry L. Testerman, compiler, History of the Air Force Engineering and Services Center, 1 January 1978 – 31 December 1978, Vol 1, 1979, ii; CMSgt. Larry L. Testerman, compiler, History of the Air Force Engineering and Services Center, 1 January – 31 December 1979, Vol 1, 1980, ii.

78 Maj. Gen. Clifton D. Wright, Jr. (USAF, Retired), "Oral History Interview," interview by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, May 2002, 61; Dr. Ronald B. Hartzer, "AFESC Celebrates its Birthday," *Air Force Engineering & Services Update*, July-August 1989, 12-13.

79 Dr. Ronald B. Hartzer, "Foundations for the Future: A Brief History of Air Force Civil Engineers," ca. 2005.

80 CMSgt. Larry L. Testerman, compiler, History of the Air Force Engineering and Services Center, 1

January 1978 – 31 December 1978, Vol 1, 1979, 6-11.

81 Maj. Gen. Clifton D. Wright, Jr. (USAF, Retired), "Oral History Interview," interview by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, May 2002, 61; Dr. Ronald B. Hartzer, "AFESC Celebrates its Birthday," *Air Force Engineering & Services Update*, July-August 1989, 12-13.

82 George K. Dimitroff, "Air Force Engineering and Services Center: A New Focal Point for Worldwide Activities," *ESQ*, Vol 19, No 4, November 1978, 20.

83 "Engineering and Services Center Relocated," *TME*, Vol 72, No 466, March-April 1980, 119; Maj. Jeffrey H. Markey, PE, "New Home for the Air Force Engineering and Services Center," *ESQ*, Vol 20, No 4, November 1979, 2-5; Gen. Wilbur L. Creech, "In Dedication…General Creech's Comments: Dedication of the Air Force Engineering and Services Center Building in Memory of Major General Robert C. Thompson, USAF, Tyndall AFB, Florida, July 1, 1982," *ESQ*, Vol 23, No 3, Fall 1982, 24.

84 Public Announcement, "Air Force Decision to Realign Departmental Headquarters and Reduce Staff in the National Capital Region (NCR)," 14 Apr 1978; History of the Directorate of Engineering and Services, DCS/P&R, 1 Jan-30 Jun 1978, 128.

85 Maj. Gen. William D. Gilbert (USAF, Retired), "Oral History Interview," interview by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, September 2002, 66.

86 CMSgt. Larry L. Testerman, compiler, History of the Air Force Engineering and Services Center, 1 January – 31 December 1979, Vol 1, 1980, 3.

87 Ibid.

88 Maj. Gen. William D. Gilbert, "Decade of the Challenge…the 1980s," *ESQ*, Vol 21, No 1, February 1980, 3-4; U.S. Air Force Engineering and Services Center, U.S. Air Force Fact Sheet 82-35, 1982.

89 CMSgt. Larry L. Testerman, compiler, History of the Air Force Engineering and Services Center, 1 January – 31 December 1979, Vol 1, 1980, 11, 73.

90 "AFESC Seeks Design for Symbolic Seal," *Engineering & Services Quarterly*, Vol 19, No 4, November 1978, n.p.

91 "A New Emblem for the AFESC," *Engineering & Services Quarterly*, Vol 20, No 4, November 1979, n.p.

92 U.S. Air Force Engineering and Services Center, U.S. Air Force Fact Sheet 82-35, 1982; CMSgt. Larry L. Testerman, compiler, History of the Air Force Engineering and Services Center, 1 January – 31 December 1979, Vol 1, 1980, 8-9.

93 Maj. Ronald C. Bunch, "The Traveling Teams of the AFESC," *ESQ*, Vol 20, No 4, November 1979, 10-12.

94 Dr. Ronald B. Hartzer, "AFESC Celebrates its Birthday," *Air Force Engineering & Services Update*, July-August 1989, 12-13.

95 U.S. Air Force Engineering and Services Center, U.S. Air Force Fact Sheet 82-35, 1982.

96 Maj. Edward L. Parkinson, "Getting a Handle on Co$t," *ESQ*, Vol 23, No 2, Summer 1982, 20-24.

97 Maj. Gen. Clifton D. Wright, Jr. (USAF, Retired), "Oral History Interview," interview by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, May 2002, 90.

98 "AFCESA Technologies Cited by CERF," Air Force Civil Engineering Support Agency, *CE Update*, Vol 3, No 4, December 1991, 12.

99 Maj. Gen. Clifton D. Wright, Jr., "Strategy for Tomorrow Moving Forward with a Strategic Plan," *ESQ*, Vol 25, No 1, Spring 1984, 4; "Directorate of Engineering and Services Current Emphasis," *ESQ*, Vol 24, No 1, Spring 1983, 30.

100 "New AFESC Directorate Formed," *ESQ*, Vol 24, No 3, Fall 1983, 28; MSgt James P. Denney, History of the Air Force Engineering and Services Center, 1 Jan - 31 Dec 83, 71-73.

101 "Directorate of Engineering and Services Current Emphasis," *ESQ*, Vol 24, No 2, Summer 1983, 23.

102 Maj. Theodore M. Golondzinier, "Doing More with Less," *ESQ,* Vol 24, No 1, Spring 1983, 8.

103 Dr. Ronald B. Hartzer, "AFESC Celebrates its Birthday," *Air Force Engineering & Services Update*, July-August 1989, 12-13.

104 Maj. Gen. George E. Ellis, "Strength Through Partnership," *TME*, January-February 1988, 26-28.

105 CMSgt. Larry L. Testerman, compiler, History of the Air Force Engineering and Services Center, 1 January 1978 – 31 December 1978, Vol 1, 1979, 17, 42; CMSgt. Larry L. Testerman, compiler, History of the Air Force Engineering and Services Center, 1 January – 31 December 1979, Vol 1, 1980, 9.

106 DAF/PRM 072q, 24 March 1977, Air Force Historical Research Agency, Maxwell AFB, Alabama; DAF/MPM, 198q, 29 September 178 and HQ AFESC SO G-36, 8 October 1978, Air Force Historical Research Agency, Maxwell AFB, Alabama; HQ AFESC SO G-2, 12 March 1979, Air Force Historical Research Agency, Maxwell AFB, Alabama.

107 DAF/PRM 072q, 24 March 1977, Air Force Historical Research Agency, Maxwell AFB, Alabama; DAF/MPM 198q, 29 September 1978 & HA AFESC AO G-36, 8 October 1978, Air Force Historical Research Agency, Maxwell AFB, Alabama; DAF/MEM 226a, 5 March 1979 & HQ AFESC SO-G-3, 12 March 1979, Air Force Historical Research Agency, Maxwell AFB, Alabama.

108 Lt. Col. John R Harty, "An Analysis of Air Force Civil Engineering Research and Development Management," Research Report, Air War College, Maxwell AFB, Alabama, 1978, 20; "Civil Engineering Laboratory," AHO.

109 Lt. Col. John R Harty, "An Analysis of Air Force Civil Engineering Research and Development Management," Research Report, Air War College, Maxwell AFB, Alabama, 1978, 21.

110 HQ AFESC SO G-42, 15 November 1978, Air Force Historical Research Agency, Maxwell AFB, Alabama; HQ AFSC SO G-163, 17 November 1978, Air Force Historical Research Agency, Maxwell AFB, Alabama.

111 CMSgt. Larry L. Testerman, compiler, History of the Air Force Engineering and Services Center, 1 January – 31 December 1979, Vol 1, 1980, 9.

112 Ibid.

113 Robert E. Boyer and Philip T. Nash, "North Field," *ESQ*, Vol 22, No 2, Summer 1981, 16.

114 CMSgt. Larry L. Testerman, compiler, History of the Air Force Engineering and Services Center, 1 January – 31 December 1979, Vol 1, 1980, 56.

115 Robert E. Boyer and Philip T. Nash, "North Field," *ESQ*, Vol 22, No 2, Summer 1981, 16.

116 "Civil Engineering Laboratory," AHO.

117 William D. Gilbert, "Air Force Engineering Meeting Global Challenges," *TME,* Vol 73, No 471, January-February 1981, 10-11.

118 "Civil Engineering Laboratory," AHO.

119 K. Stuart Millard, "Airfield Pavements…A Valuable Resource," *ESQ*, Vol 24, No 2, Summer 1983, 24.

120 Anthony J. Kwan and J.D. Wilson, "On the Razor's Edge of Technology," *ESQ*, Vol 23, No 1, Spring 1982, 29-30.

121 "Mr. 'B' Retires," *Engineering & Services Quarterly*, Fall 1984, 21

122 Anthony J. Kwan and J.D. Wilson, "On the Razor's Edge of Technology," *ESQ*, Vol 23, No 1, Spring 1982, 30.

123 Ibid., 30-32.

124 Lt. Col. Michael J. Ryan, "Environmental Quality R&D: Investigating Tomorrow's Problems Today," *ESQ*, Vol 23 No 4, Winter 1982-1983, 14-15.

125 Ibid.

126 "Tecnotes," *ESQ*, Vol 24, No 2, Summer 1983, 39.

127 Capt. Anthony J. Kwan and Capt. J.D. Wilson, "On the Razor's Edge of Technology," *ESQ*, Vol 23, No 1, Spring 1982, 29-30.

128 "Mr. 'B' Retires," *ESQ*, Vol 25, No 3, Fall 1984, 21.

129 "Civil Engineering Laboratory." AHO.

130 "New E&S Laboratory Construction Begins," *Air Force Engineering & Services Update*, Fall 1984, 22.

131 "Civil Engineering Laboratory." AHO.

132 Mr. Henry A. Collin was selected to serve as the first Deputy Director of Program, but passed away before his Senior Executive Service appointment was approved and the position was never filled. Maj. Gen. George E. Ellis, "Air Force Civil Engineering: Shaping Our Future Combat Capability," *TME*, Vol 81, 519, January-February 1989, 22-25.

133 "New Division Formed: Installation Development Division Gets Charter in Reorganization," *Air Force Engineering & Services Update*, January-February 1989, 5.

134 "New Division Created in Washington," *Air Force Engineering & Services Update*, April-May 1989, 6.

135 "AFESC SOA Review," Col. Marshall Nay, 15 Aug 90, AHO: Biography, Brig. Gen. David M. Cannan, 2002.

136 Maj. Gen. Joseph A. Ahearn (USAF, Retired), "Oral History Interview," interview by Dr. Douglas H. Merkle and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, March 2008, 109, xii.

137 Kenneth Miller, Email to Ron Hartzer, 23 May 2011, AHO; Maj. Gen. Joseph A. Ahearn (USAF, Retired), "Oral History Interview," interview by Dr. Douglas H. Merkle and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, March 2008, 89.

138 Brig. Gen. Bernard C. Meredith, PE, "What's New in Programming," *ESQ*, Vol 18, No 1, February 1977, 34-37; H. Perry Sullivan, Jr., "J.B. Cole Retires at AFCEE," *The U.S. Air Force Civil Engineer*, Vol 1, No 10, December 1993, 14.

139 See Note Above.

140 Col. Joseph A. (Bud) Ahearn, "If it Ain't in the POM it Ain't in the Budget: Interview with Col. Joseph A. (Bud) Ahearn," *ESQ*, Vol 23, No 2, Summer 1982, 34.

141 Ibid.

142 Col. G.E. "Jud" Ellis, "CESMET: An Update," *ESQ*, Vol 18, No 3, August 1977, 16-17.

143 Brig. Gen. Bernard C. Meredith, PE, "What's New in Programming," *ESQ*, Vol 18, No 1, February 1977, 34-37.

144 Col. Joseph A. (Bud) Ahearn, "If it Ain't in the POM it Ain't in the Budget: Interview with Col. Joseph A. (Bud) Ahearn," *ESQ*, Vol 23, No 2, Summer 1982, 34-37.

145 Maj. Gen. William D. Gilbert (USAF, Retired), "Oral History Interview," interview by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, September 2002, 58.

146 Col. Joseph A. (Bud) Ahearn, "If it Ain't in the POM it Ain't in the Budget: Interview with Col. Joseph A. (Bud) Ahearn," *ESQ*, Vol 23, No 2, Summer 1982, 34-37.

147 Arthur B. Markowitz, "The 'Forum'," *ESQ*, Vol 25, No 3, Fall 1985, 28-30.

148 Col. Joseph A. (Bud) Ahearn, "If it Ain't in the POM it Ain't in the Budget: Interview with Col. Joseph A. (Bud) Ahearn," *ESQ*, Vol 23, No 2, Summer 1982, 34-37.

149 Col. G.E. "Jud" Ellis, "CESMET: An Update," *ESQ*, Vol 18, No 2, August 1977, 16-17.

150 Col. Joseph A. (Bud) Ahearn, "If it Ain't in the POM it Ain't in the Budget: Interview with Col. Joseph A. (Bud) Ahearn," *ESQ*, Vol 23, No 2, Summer 1982, 34-37.

151 Lt. Col. Jeffrey H. Markey, "Golden Opportunity," *ESQ*, Vol 26, No 1, Spring 1985, 22-23.

152 Maj. Gen. Clifton D. Wright, Jr. (USAF, Retired), "Oral History Interview," interview by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, May 2002, 89.

153 Maj. Gen. Clifton D. Wright, Jr. (USAF, Retired), "Oral History Interview," interview by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, May 2002, 90; Maj. Edward L. Parkinson, "Getting a Handle on Co$t," *ESQ*, Vol 23, No 2, Summer 1982, 20-24.

154 H. Perry Sullivan, Jr., "J.B. Cole Retires at AFCEE," *The U.S. Air Force Civil Engineer*, Vol 1, No 10, December 1993, 14

155 Lt. Col. O.F. Smith, EIT, "Our Ability to Fly and Fight: A Matter of Readiness," *ESQ*, Vol 18, No 3, November 1977, 3-7; Lt. Col. Eugene A. Lupia, "When the Balloon Goes Up," *Engineering & Services Quarterly*, Spring 1982, 24-27; Directorate of Engineering and Services History, 1 July – 31 December 1976, 82-84, AHO.

156 Maj. Gen. William D. Gilbert (USAF, Retired), "Oral History Interview," interview by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, September 2002, 72.

157 Lt. Col. O.F. Smith, EIT, "Our Ability to Fly and Fight: A Matter of Readiness," *ESQ*, Vol 18, No 3, November 1977, 3-7.

158 Maj. Gen. William D. Gilbert (USAF, Retired), "Oral History Interview," interview by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, September 2002, 72; *Formal Report of the Civil Engineering Manpower Study Group (Project Prime Beef)*, 1964, 2-4.

159 Maj. Gen. William D. Gilbert (USAF, Retired), "Oral History Interview," interview by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, September 2002, 72

160 Ibid., 70.

161 Ibid., 70-71.

162 Lt. Col. O.F. Smith, EIT, "Our Ability to Fly and Fight: A Matter of Readiness," *ESQ*, Vol 18, No 3, November 1977, 3-7.

163 Ibid.

164 Maj. Gen. William D. Gilbert (USAF, Retired), "Oral History Interview," interview by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, September 2002, 69-72.

165 Ibid.

166 Department of Defense Directive Number 1315.6, 26 August 1978, 2-3.

167 CMSgt. Larry L. Testerman, compiler, History of the Air Force Engineering and Services Center, 1 January – 31 December 1979, Vol 1, 1980, 73-74; Capt. David G. Wingad, "Readiness through Prime BEEF: A Look Into the Future," *Engineering & Services Quarterly*, Vol 18, No 4, November 1977, 9-10.

168 Directorate of Engineering and Services Current Emphasis," *ESQ*, Vol 22, No 4, Winter 1981-1982, 23.

169 Maj. Gen. William D. Gilbert, "Reflections," *ESQ*, Vol 23, No 2, Summer 1982, 47.

170 Ibid.

171 Maj. Robert J. Courter, Jr., "Base Level Management Plan: a systematic approach to managing, analysis and problem solving," *ESQ*, Vol 19, No 2, May 1978, 3.

172 Maj. Gen. William D. Gilbert (USAF, Retired) "Oral History Interview," interview by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, September 2002, 57-59.

173 Ibid., 59.

174 Ibid.

175 Ibid., 87-88.

176 Maj. Paul Hains, "Image," *ESQ*, Vol 25, No 1, Spring 1984, 8-9; "Image," *ESQ*, Vol 25, No 3, Fall 1984, 13.

177 "Image," *ESQ*, Vol 25, No 3, Fall 1984, 13.

178 Maj. Paul Hains, "Image," *ESQ*, Vol 25, No 1, Spring 1984, 8-9; Maj. Patrick M. Coullahan, "Building Image: Innovative Management Achieves Greater Effectiveness," *ESQ*, Vol 26, No 1, Spring 1985, 14-17.

179 "Image," *ESQ*, Vol 25, No 3, Fall 1984, 13.

180 "Image," *ESQ*, Vol 25, No 3, Fall 1984, 13.

181 Maj. Paul Hains, "Image," *ESQ*, Spring 1984, 8-9; "Image," *ESQ*, Vol 25, No 3, Fall 1984, 13; Capt. John E. Bravo, "Designing the right tools, adequate communications and a productive place to work…," *ESQ*, Spring 1986, 30-32.

182 Maj. Patrick Coullahan, "Building IMAGE, Innovative Management Achieves Greater Effectiveness," *ESQ*, Vol 26, No 1, Spring 1985, 16; Booz, Allen & Hamilton, "Base Civil Engineering General Purpose Vehicle Evaluation Study," Jan 1988, AHO; AFESC Weekly Activity Report, 9 Mar 88, Files of AFCES History Office,

Tyndall AFB, Florida.

183 Maj. Gen. Clifton D. Wright, Jr. (USAF, Retired), "Oral History Interview," interview by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, May 2002, viii.

184 Ibid., 91.

185 H. Perry Sullivan, Jr., "An Interview with Brigadier General Jud Ellis the Innovator," *ESQ*, Vol 24, No 4, Winter 1983, 10; Col. Marshall W. Nay, Jr., "Oral History Interview," interview by Dr. Ronald B. Hartzer, HQ AFCESA Tyndall AFB, Florida, May 2008, 13; Walter J. Boyne, "The Genius of this Singular Officer Lives on in the Modern United States Air Force, Creech," *Air Force Magazine*, March 2005, 73.

186 H. Perry Sullivan, Jr., "An Interview with Brigadier General Jud Ellis the Innovator," *ESQ*, Vol 24, No 4, Winter 1983, 11.

187 Ibid., 10-11.

188 Maj. Gen. William D. Gilbert (USAF, Retired) "Oral History Interview," interview by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, September 2002, 110; Maj. Gen. Clifton D. Wright, Jr. (USAF, Retired), "Oral History Interview," interview by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, May 2002, 42; Walter J. Boyne, "The Genius of this Singular Officer Lives on in the Modern United States Air Force, Creech," *Air Force Magazine*, March 2005, 73.

189 Lea G. Blake, "One-of-a-Kind Team," *ESQ*, Vol 24, No 4, Winter 1983, 16.

190 Maj. Gen. Clifton D. Wright, Jr. (USAF, Retired), "Oral History Interview," interview by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, May 2002, 91; Maj. Gen. James E. McCarthy, "Oral History Interview," interview by Dr. Douglas H. Merkle and Lois E. Walker, June 2005, 39-41

191 "Installation Design," Air Force Manual 88-43, 1981, 2.

192 H. Perry Sullivan, Jr., "An Interview with Brigadier General Jud Ellis the Innovator," *ESQ*, Vol 24, No 4, Winter 1983, 10-11.

193 Walter J. Boyne, "The Genius of this Singular Officer Lives on in the Modern United States Air Force, Creech," *Air Force Magazine*, March 2005, 73.

194 18th Wing Public Affairs, "Kadena Wins CINC's Installation Excellence Award for PACAF," 9 October 2010, accessed April 2011, http://www.kadena.af.mil/news/story.asp?id=123225820, accessed.

195 Lt. Col. Richard J. Toner, "The Total Force Concept," *Air University Review,* November-December 1972, accessed May 2011, www.airpower.au.af.mil/airchronicles/aureview/1972/nov-dec/toner.html.

196 Ibid.

197 Lt. Gen. Philip C. Gast, "Operators & Engineers: Readiness Partners," *ESQ*, Vol 22, No 4, Winter 1981-1982, 10.

198 "Civil Engineering Officer Exchange Program," *ESQ*, Vol 16, No 1, February 1975, 33.

199 Maj. Richard L. Brown, "The AFCE in a Joint Environment," *ESQ*, Vol 20, No 4, November 1979, 22-28.

200 U.S. Army Environmental Center, Thematic Study and Guidelines: Identification and Evaluation of U.S. Army Cold War Era Military-Industrial Historic Properties, 1997, 61.

201 Lt. Col. Peter W. Chiarelli, "Goldwater-Nichols Revisited: A Proposal for Meaningful Defense Reorganization," Thesis, Army War College, 1993, 1-7.

202 Maj. Gen. George E. Ellis, "Air Force Civil Engineering: Shaping Our Future Combat Capability," *TME*, Vol 81, No 519, January-February 1989, 22-23.

203 Ibid.

204 Maj. Donald R. Barrett, "Facilities to Support our People," *ESQ*, Vol 23, No 2, Summer 1982, 26.

205 U.S. Department of the Air Force, AF Regulation 85-10, *Operation and Maintenance of Real Property*, Government Printing Office, Washington, D.C., 1975.

206 H. Perry Sullivan, "A Change at the Top," *ESQ*, Vol 23, No 2, Summer 1982, 30; Maj.Gen. Clifton D. Wright, Jr., "Image with a Small I," *ESQ*, Vol 26, No 1, Spring 1985, 4.

207 "Be Visible: An Interview that Worked-McClellan's BCE Discusses Plans Programs and Issues," *ESQ*, Vol 25, No 3, Fall 1984, 36-38.

208 Lt. Col. Eugene Garove, "Successful O&M Work Planning," *Air Force Civil Engineer,* Vol 16, No 1, February 1975, 6.

209 Ibid., 7.

210 "Be Visible: An Interview that Worked-McClellan's BCE Discusses Plans Programs and Issues," *ESQ*, Vol 25, No 3, Fall 1984, 36-38.

211 Col. George E. Ellis, "CESMET…in Support of the Mission and People," *ESQ*, Vol 16, No 3, August 1975, 3.

212 Maj. Gen. Clifton D. Wright, Jr. (USAF, Retired), "Oral History Interview," interview by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, May 2002, 34.

213 Col. George E. Ellis, "CESMET…in Support of the Mission and People," *ESQ*, Vol 16, No 3, August 1975, 3; "Civil Engineering and Services Management Evaluation Team (CESMET) History," 2006, AHO.

214 Col. George E. Ellis, "CESMET…in Support of the Mission and People," *ESQ*, Vol 16, No 3, August 1975, 3; Col. G.E. 'Jud' Ellis, "CESMET: An Update," *ESQ*, Vol 18, No 3, August 1977, 16-17.

215 "CESMET Tips," *ESQ,* Vol 23, No 3, Fall 1982, 33

216 "CESMET Tips," *ESQ,* Vol 24, No 1, Spring 1983, 29; "CESMET Tips," *ESQ*, Vol 21, No 2, May

1980, 31; "CESMET Tips," *ESQ,* Vol 23, No 1, Spring 1982, 22.

217 Maj. Gen. Clifton D. Wright, Jr. (USAF, Retired), "Oral History Interview," interview by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, May 2002, 49.

218 Maj. Gen. Eugene A. Lupia (USAF, Retired), "Oral History Interview," interview by Dr. Douglas H. Merkle and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, May and October 2002 (draft), 26.

219 "From the Director: BMAG: Search for a Better Tomorrow," *ESQ*, Vol 17, No 1, February 1976, n.p.

220 Maj, Gen. Eugene A. Lupia (USAF, Retired), "Oral History Interview," interview by Dr. Douglas H. Merkle and Lois E. Walker, AFCESA, Tyndall AFB, Florida, May and October 2002 (draft), 26.

221 Maj. Gen. Robert C. Thompson, Communication from Robert C. Thompson Maj. Gen. USAF Director, "Base Management Action Group (BMAG) Concept Paper – Base Planning and Management," April 1976, AHO.

222 H. Collin, Col. G. Ellis, Lt. Col. R. Hamel, L. Henriksen, Lt. Col. W. Sims, "Blue Print for Base Planning and Management Actions Book Two, AAF BMAG," April 1976, AHO.

223 While rejected in 1976, Services was transferred to the Department of Morale, Welfare, and Recreation in 1991.

Lt. Col. Gary C. Bradham, "Executive Research Project for the Industrial College of the Armed Forces National Defense University Integrating AF Services and MWR Organizations: Impacts, Assessment, and Recommendations," 1992; Air Staff Civil Engineering History, "Restructuring of Base Civil Engineering Organization," n.p., January-June 1977, AHO.

224 Maj. Gen. Eugene A. Lupia (USAF, Retired), "Oral History Interview," interview by Dr. Douglas H. Merkle and Lois E. Walker, AFCESA, Tyndall AFB, Florida, May and October 2002 (draft), 28.

225 Maj. Robert J. Courter, Jr PE, "Base Level Management Plan: A Systematic Approach to Managing Analysis and Problem Solving," *ESQ,* Vol 19, No 2, May 1978, 2-5, 9.

226 Air Staff History, "History of Directorate of Engineering and Services: 1 July – 31 December 1976," 73, AHO.

227 Maj. Gen. Clifton D. Wright, Jr. (USAF, Retired), "Oral History Interview," interview by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, May 2002, 40.

228 H. Perry Sullivan, Jr., "An Interview with Brigadier General Jud Ellis the Innovator," *ESQ*, Vol 24, No 4,Winter 1983, 11.

229 "General Ellis at AFIT: Highlights of his Presentation before new CEs at AFIT," *Engineering & Services Quarterly*, Spring 1986, 7-8.

230 H. Perry Sullivan, Jr., "An Interview with Brigadier General Jud Ellis the Innovator," *ESQ*, Vol 24, No 4, Winter 1983, 12.

231 Ibid., 12-14.

232 Ibid., 14.

233 Ibid., 12-13.

234 Bill Hamill, Barry R. Wentland, Tom Risher, and James F. Ruth, "When You Need It! The Way You Want It!" *ESQ,* Vol 24, No 1, Spring 1983, 12-15.

235 Maj. Gen. Clifton D. Wright, Jr., "Strategy for Tomorrow Moving Forward with a Strategic Plan," *ESQ*, Vol 25, No 1, Spring 1984, 4-6.

236 Ibid.

237 "Directorate of Engineering and Services Current Emphasis," *ESQ*, Vol 26, No 1, Spring 1985, 29.

238 "Directorate of Engineering and Services Current Emphasis," *ESQ*, Vol 26, No 2, Summer 1985, 35.

239 Maj. Theodore M. Golondzinier, "Doing More with Less," *ESQ,* Vol 24, No 1, Spring 1983, 8-11.

240 "Directorate of Engineering and Services Current Emphasis," *ESQ*, Vol 22, No 2, Summer 1981, 12.

241 "Directorate of Engineering and Services Current Emphasis," *ESQ*, Vol 25, No 2, Summer 1984, 12; Maj. Gen. Clifton D. Wright, Jr., "Strategy for Tomorrow Moving Forward with a Strategic Plan," *ESQ*, Vol 25, No 1, Spring 1984, 4.

242 Air Training Command History 1989, Vol 21.

243 Maj. Theodore M. Golondzinier, "Doing More with Less," *ESQ,* Vol 24, No 1, Spring 1983, 8-11.

244 "Directorate of Engineering and Services Current Emphasis," *ESQ*, Vol 25, No 2, Summer 1984, 12.

245 "Directorate of Engineering and Services Current Emphasis," *ESQ*, Vol 26, No 1, Spring 1985, 26.

246 Capt. Richard A. Probst and Capt. Thomas T. Taylor, "BAS/A La Carte: A Future in Air Force Feeding?," *ESQ,* Vol 18, No 2, May 1977, 14-15.

247 Maj. Gary Bain, "Good Things A'Cookin' Lowry TTC Update," *ESQ,* Vol 23, No 3, Fall 1982, 17.

248 Eleanor Linder and Maj. Jim Blanco, "Services Information Management System for Billeting," *ESQ,* Vol 24, No 1, Spring 1983, 12; Capt. Richard A. Probst and Capt. Thomas T. Taylor, "BAS/A La Carte: A Future in Air Force Feeding?," *ESQ,* Vol 18, No 2, May 1977, 14-15.

249 Eleanor Linder and Maj. Jim Blanco, "Services Information Management System for Billeting," *ESQ,* Vol 24, No 1, Spring 1983, 12; Capt. Walter T. Kelly, "Automated Food Service," *ESQ,* Vol 23, No 2, Summer 1982, 40-43.

250 Maj. Theodore M. Golondzinier, "Doing More with Less," *ESQ,* Vol 24, No 1, Spring 1983, 8-11.

251 Capt. Walter T. Kelly, "Automated Food Service," *ESQ,* Vol 23, No 2, Summer 1982, 40-43; Capt. James H. Cox, Jr., "SIMS: The Computers are Coming," *Engineering & Services Quarterly*, Fall 1984, 26.

252 Eleanor Linder and Maj. Jim Blanco, "Services Information Management System for Billeting," *ESQ,* Vol 24, No 1, Spring 1983, 12; Capt. James H. Cox, Jr., "SIMS: The Computers are Coming," *ESQ,* Vol 25, No 3, Fall 1984, 25-28.

253 Capt. James H. Cox, Jr., "SIMS: The Computers are Coming," *ESQ,* Vol 25, No 3, Fall 1984, 25-28.

254 Eleanor Linder and Maj. Jim Blanco, "Services Information Management System for Billeting," *ESQ,* Vol 24, No 1, Spring 1983, 12; Capt. James H. Cox, Jr., "SIMS: The Computers are Coming," *ESQ,* Vol 25, No 3, Fall 1984, 25-28.

255 Eleanor Linder and Maj. Jim Blanco, "Services Information Management System for Billeting," *ESQ,* Vol 24, No 1, Spring 1983, 12-13.

256 "Directorate of Engineering and Services Current Emphasis," *ESQ*, Vol 25, No 1, Spring 1984, 10.

257 "Directorate of Engineering and Services Current Emphasis," *ESQ*, Vol 26, No 1, Spring 1985, 26.

258 SMSgt. Michael Guyne, "The Engineering and Services Era: A Decade of Services Automation," *CE Update*, Vol 3, No 4, December 1991, 10.

259 Robert E. Dant, "The Computer Comes to PACAF's Construction Program," *ESQ*, Vol 25, No 1, Spring 1984, 34-35.

260 "Directorate of Engineering and Services Current Emphasis," *ESQ*, Vol 26, No 1, Spring 1985, 26.

261 "Directorate of Engineering and Services Current Emphasis," *ESQ*, Vol 26, No 2, Summer 1985, 35.

262 "Directorate of Engineering and Services Current Emphasis," *ESQ*, Vol 26, No 3, Fall 1985, 23.

263 "Directorate of Engineering and Services Current Emphasis," *ESQ*, Vol 27, No 1, Spring 1986, 38.

264 Robert J. Smith, George W. Bradley, James M. George, John Q. Smith, Vincent C. Breslin, Beatrice A.Waggener, and Alice F. Ferrell, History of Tactical Air Command 1 January-31 December 1987, 103-106.

265 "Directorate of Engineering and Services Current Emphasis," *ESQ*, Vol 27, No 2, Summer 1986, 23.

266 Robert J. Smith, George W. Bradley, James M. George, John Q. Smith, Vincent C. Breslin, Beatrice A.Waggener, and Alice F. Ferrell, History of Tactical Air Command 1 January-31 December 1987, 103-106.

267 Air Training Command History 1989, Vol 21.

268 SMSgt. Michael Guyne, "The Engineering and Services Era: A Decade of Services Automation," *CE Update*, Vol 3, No 4, December 1991, 10-11.

269 "Computer A&D Update," *Air Force Engineering & Services Update*, Vol 2, No 9, November 1990, 25.

270 Maj. Theodore M. Golondzinier, "Doing More with Less," *ESQ,* Vol 24, No 1, Spring 1983, 8-11.

271 Maj. John Dleltz, "Study Justifies WIMS Use by Base-Level Units," *Air Force Engineering & Services Update*, Vol 2, No 5, June 1990, 12.

272 Maj. Gen. Joseph A. Ahearn (USAF, Retired), "Oral History Interview," interview by Dr. Douglas H. Merkle and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, March 2008, 101.

273 Maj. Theodore M. Golondzinier, "Doing More with Less," *ESQ,* Vol 24, No 1, Spring 1983, 8-11.

274 John J. Lieb, PE and Capt. David G. Beers, "Quality Control—Quality Assurance for Service Contract Surveillance," *ESQ*, Vol 19, No 2, May 1978, 10-14.

275 Maj. Gen. Joseph A. Ahearn (USAF, Retired), "Oral History Interview," interview by Dr. Douglas H. Merkle and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, March 2008, 49.

276 Douglas Dalessio, "Material Support," *ESQ*, Vol 19, No 2, May 1978, 17-20.

277 Directorate of Engineering and Services Current Emphasis," *ESQ*, Vol 18, No 4, November 1977, 12.

278 Directorate of Engineering and Services Current Emphasis," *ESQ*, Vol 18, No 1, February 1977, 12.

279 Directorate of Engineering and Services Current Emphasis," *ESQ*, Vol 22, No 2, Summer 1981, 11.

280 Directorate of Engineering and Services Current Emphasis," *ESQ*, Vol 18, No 2, May 1977, 11.

281 J.D. Hunley, *The San Antonio Real Property Maintenance Agency: A Case Study of Centralization*, History and Research Office, Headquarters Air Training Command, 1990, 1-2, 15.

282 J.D. Hunley, *The San Antonio Real Property Maintenance Agency: A Case Study of Centralization*, History and Research Office, Headquarters Air Training Command, 1990, 105-107; Report, "In-Depth Review of the San Antonio Real Property Maintenance Agency (SARPMA): Prepared at the request of the Vice Chief of Staff of the United States Air Force," Programs and Long Range Planning Directorate, DCS Plans, Air Training Command, November 1983, AHO.

283 Maj. Donald R. Barrett, "Facilities to Support our People," *ESQ*, Vol 23, No 2, Summer 1982, 26-28.

284 John J. Lieb, PE and Capt. David G. Beers, "Quality Control—Quality Assurance for Service Contract Surveillance," *ESQ*, Vol 19, No 2, May 1978, 10-14.

285 Directorate of Engineering and Services Current Emphasis," *Engineering & Services Quarterly*, Spring 1985, 31.

286 Maj. Gen. Clifton D. Wright, Jr. (USAF, Retired), "Oral History Interview," interview by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, May 2002, 102; Dr Ronald B. Hartzer, "10 USC 2667 Visitors Quarters Projects History," 1988, AHO.

287 Perry Sullivan, "Air Force Breaks Ground for Private Development," *E&S Update*, April-May, 1990, 5; Rick Baker, "New Hotel Opens at Wright-Patterson: Vision Becomes Reality," *E&S Update*, January 1991, 8-9.

288 Maj. Gen. Clifton D. Wright, Jr. (USAF, Retired), "Oral History Interview," interview by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, May 2002, 102.

289 "Build/lease for Housing Nears Test," *ESQ*, Vol 25, No 1, Spring 1984, 18.

290 Capt. Kurt Kaisler, "SABER Now a Way of Life for Bases," *ESQ*, Vol 2, No 7, July 1990, 7; "SABER Cuts Through Time and Costs," *Air Force Engineering & Services Update*, July-August 1989, 22.

291 "SABER Cuts Through Time and Costs," *Air Force Engineering & Services Update*, July-August 1989, 22.

292 Capt. Kurt Kaisler, "SABER Now a Way of Life for Bases," *Air Force Engineering & Services Update*, Vol 2, No 7, July 1990, 7.

293 "SABER Cuts Through Time and Costs," *Air Force Engineering & Services Update*, July-August 1989, 22.

294 Ibid.

295 Capt. Kurt Kaisler, "SABER Now a Way of Life for Bases," *Air Force Engineering & Services Update*, Vol 2, No 7, July 1990, 6.

296 "Proposed AFB Closings," *TME*, Vol 69, No 447, January-February 1977, 49.

297 "Base Realignment and Closure (BRAC)," GlobalSecurity.org, accessed January 2010, www.globalsecurity.org.

298 "Base Realignment and Closure (BRAC)," GlobalSecurity.org, accessed January 2010, www.globalsecurity.org; Frederick J. Shaw, Ed. Locating Air Force Base Sites: History's Legacy, Air Force History and Museums Program, United States Air Force, Washington DC, 2004, 151-94.

299 "Base Realignment and Closure (BRAC)," GlobalSecurity.org, accessed January 2010, www.globalsecurity.org.

300 Harry P. Rietman, "Oral History Interview," interview by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, November 2004, 19.

301 Capt. Ronald Andreas, Jr., "The Blizzard of '79," *ESQ*, Vol 22, No 1, February 1981, 30-32; Col. Charles W. Sampson, PE, "Get SMART," *AFCE*, Vol 11, No 4, November 1970, 5-7.

302 Sheldon J. Lustig, "The Military Family Housing U-Fix-It Store," ESQ, August 1975, 21-24.

303 SMSgt. David A. Tanner, "Air Force Self-help Centers: The Wave of the Future," Air Force Engineering & Services Update, Vol 2, No 9, November 1990, 14.

304 "MSgt. Cherry Receives $750 for Suggestion," The Spangled Banner, Spangdahlem, Germany, Vol 4, No 11, 30 May 1975, 1, 5.

305 "Readiness and Ownership Oriented Management (ROOM), Strategic Air Command, nd. AHO; Harry P. Rietman, "Oral History Interview," interview by Lois E. Walker, , HQ AFCESA, Tyndall AFB, Florida, November 2004, 19.

306 Maj. Michael D. Cooley, "Zonal Maintenance: Old Idea, New Promise," Air Force Engineering & Services Update, Vol 2, No 8, September 1990, 6-7; "Zonal Maintenance Guide," prepared by HQ AFESC, 1990, n.p.

307 E-mail, Col. Ray Schwartz, USAF (Ret) to Dr. Ronald B. Hartzer, "CE History Book Review," 7 Nov 13, AHO.

308 "Zonal Maintenance Guide," prepared by HQ AFESC, 1990, n.p.

309 Ibid.

310 "Room at the Top," Air Force Engineering & Services Update, Vol 1, No 1, August 1988, 8.

311 Maj. Michael D. Cooley, "Zonal Maintenance: Old Idea, New Promise," Air Force Engineering & Services Update, Vol 2, No 8, September 1990, 6-7; "Zonal Maintenance Guide," prepared by HQ AFESC, 1990.

312 Eugene A. Lupia, "The Operations Flight," The Civil Engineer, Winter 1997-98, n.p.

313 Col. William M. Shaw PE, John B. Frounfelker PE, and Robert H. Keegan PE, "Energy Productivity A Major Air Force Initiative To Light the Way" ESQ, Vol 19 No 1, February 1978, 3.

314 Mrs. Lois E. Walker, "Oral History Interview with Mr. Freddie L. Beason," 28 March 1999, 20-22.

315 Lt. Col. William R. Gaddie, PE and Capt.Thomas F. Wilson "Air Force Facility Energy Program," ESQ, Vol 20 No 4, November 1979, 7; AFESC History, CY 1978, 9.

316 Tetra Tech Inc, U.S. Air Force Energy Plan 1978, prepared for Chief of Staff USAF, July 1978, 1, AHO; Maj. Gen. William D. Gilbert, "Air Force Engineering Meeting Global Challenges," TME, Vol 73, No 471, January-February 1981, 8-9; "Air Force Energy Program Policy Memorandum," 2 October 1985 AHO.

317 Col. James R. Hawkins, PE "Contemporary Issues: Air Force Facility Energy Program," ESQ, Vol 19 No 1, February 1978, 9.

318 "Air Force Facility Energy Plan FY76-85" Vol II, 1 July 1979, AHO.

319 Maj. Ronald C. Bunch, "The Traveling Teams of the AFESC," ESQ, Vol 20, No 4, November 1979, 11.

320 John Ginovsky, "Air Force Looks to Alternate Sources for Light, Heat," AF Times 10 December 1985.

321 Roman A. Metz PE, "No More Yet No Less" ESQ, Vol 17, No 3, 1976, 13.

322 Tetra Tech Inc, U.S. Air Force Energy Plan 1978, prepared for Chief of Staff USAF, July 1978, 1, AHO.

323 John Ginovsky, "Energy Use Increases in Family Housing," AF Times 16 December 1985; Freddie L. Beason, "Air Force Approach to Energy Conservation," Air Force Civil Engineering Support Agency Update, Vol 4, No 3, September 1992, 8.

324 "Bullet Background Paper on Air Force Facility Energy Program History, AFCESA, Tyndall AFB"

AHO.

325 Col. Marshall W. Nay, Jr, “Commander’s Column: The Energy Challenge,” Air Force Engineering & Services Update, Vol 2, No 9, November 1990, 4.

326 Maj. Gen. William D. Gilbert, “Air Force Engineering Meeting Global Challenges,” TME, Vol 73, No 471, January-February 1981, 9.

327 Freddie L. Beason, “Air Force Approach to Energy Conservation,” CE Update, Vol 4, No 3 September 1992, 8.

328 Maj. Gen. Billy J. McGarvey, “From the Director: Meeting Challenges Through Environmental Planning,” AFCE, Vol 16, No 1, February 1975, 1-2.

329 Maj. Gen. Billy J. McGarvey, “From the Director: Meeting Challenges Through Environmental Planning,” AFCE, Vol 16, No 1, February 1975, 1-2; Maj. Gen. Billy J. McGarvey, “Air Force Environmental Planning,” TME, Vol 67, No 435, January-February 1975, 5-7; Staff History, Directorate of Civil Engineering, July-December 1973.

330 Gil Dominguez, “Urban Encroachment Continues to Dog Installations,” CenterViews Spring 2001, 3.

331 “Air Force News: AICUZ Studies,” TME, Vol 69, No 448, Mar-April 1977, 125.

332 Maj. Bobbie L. Griffin and Maj. George R. Velasco, The Air Force Environmental Quality Program: A Historical Look at Air Force Efforts to Achieve Environmental Excellence, research paper for Air Command and Staff College, April 1996, 14-16.

333 Joan Scott and Capt. Stephen Hann, “Roots: Preserving Our History,” ESQ, Vol 21, No 4 November 1980.

334 Lt. Col. Thomas E. Peot, “Challenges From the Environment,” ESQ, Vol 21 No 4 November 1980 3; “National Pollutant Discharge Elimination System (NPDES),” Environmental Protection Agency, accessed April 5, 2011, http://cfpub.epa.gov/npdes/.

335 U.S. General Accounting Office, “Hazardous Waste Status of Air Force’s Installation Restoration Program,” Briefing Report to Representative Vic Fazion, House of Representatives, December 1982, 1-6; Air Force Engineering and Services Center, “Air Force Installation Restoration Program Management Guidance,” July 1985, 1-3.

336 SrA. Sheri L. Sams, “AMC Base Attains Environmental Cleanup ‘First,’” AFCE, Vol 4 No 1 Spring 1996, 9.

337 USAF, AFI 32-7045, Environmental Compliance Assessment and Management Program ECAMP, 1 July 1985, 3, accessed April 5, 2011, www.keesler.af.mil/shared/media/document/AFD-070221-022.pdf .

338 Weekly Activity Report, “Environmental Quality Division, 12 Oct 1990, AHO; Notes on Interview with Don Kane, AHO; HQ AFCEE, “PROACT Fact Sheet: ECAMP,” October 2005, 1, accessed April 2011, www.afcee.af.mil/shared/media/document/AFD-070924-128.pdf.

339 Notes on Interview with Don Kane, AHO.

340 History, HQ USAF/ILE, Environmental Division, July-December 1986; Notes on Interview with Don Kane, AHO.

341 National Agricultural Library Special Collections, Alvin L. Young Collection on Agent Orange, Department of the Air Force Environmental Statement on the Disposition of Orange Herbicide by Incineration, November 1974, 4, accessed February 2, 2011, www.nal.usda.gov/speccoll/findaids/agentorange.

342 National Agricultural Library Special Collections, Alvin L. Young Collection on Agent Orange, Pamela W. Smith, “Agent Orange: Veterans’ Complaints Concerning Exposure to Herbicides in South Vietnam Issue Brief Number IBS0040,” Science Policy Research Division, September 6 1979, 1, accessed February 2, 2011, www.nal.usda.gov/speccoll/findaids/agentorange.

343 National Agricultural Library Special Collections, Alvin L. Young Collection on Agent Orange, Pamela W. Smith, “Agent Orange: Veterans’ Complaints Concerning Exposure to Herbicides in South Vietnam Issue Brief Number IBS0040,” Science Policy Research Division, September 6 1979, 2, accessed February 2, 2011, www.nal.usda.gov/speccoll/findaids/agentorange; Committee to Review the Health Effects in Vietnam Veterans of Exposure to Herbicides, Division of Health Promotion & Disease Prevention, Institute of Medicine, Veterans and Agent Orange: Health Effects of Herbicides Used in Vietnam, National Academy Press, Washington, D.C., 1994, 30.

344 National Agricultural Library Special Collections, Alvin L. Young Collection on Agent Orange, Pamela W. Smith, “Agent Orange: Veterans’ Complaints Concerning Exposure to Herbicides in South Vietnam Issue Brief Number IBS0040,” Science Policy Research Division, September 6, 1979, 6, accessed February 2, 2011, www.nal.usda.gov/speccoll/findaids/agentorange ; Maj. William A. Buckingham, Jr., “Operation Ranch Hand: Herbicides In Southwest Asia,” Air University Review, July-August 1983.

345 National Agricultural Library Special Collections, Alvin L. Young Collection on Agent Orange, Pamela W. Smith, “Agent Orange: Veterans’ Complaints Concerning Exposure to Herbicides in South Vietnam Issue Brief Number IBS0040,” Science Policy Research Division, September 6, 1979, 7-8, accessed February 2, 2011, www.nal.usda.gov/speccoll/findaids/agentorange.

346 Ibid.

347 National Agricultural Library Special Collections, Alvin L. Young Collection on Agent Orange, Albert N. Rhodes, “Herbicide Orange Monitoring Program Addendum I, January 1980 – February 1985,” Engineering & Services Laboratory, Air Force Engineering & Services Center, Tyndall AFB, Florida, May 1985, 1, accessed

February 3, 2011, www.nal.usda.gov/speccoll/findaids/agentorange/index.htm.

348 National Agricultural Library Special Collections, Alvin L. Young Collection on Agent Orange, U.S. Environmental Protection Agency, Transcript: Public Hearing – "Incinerate Herbicide Orange at Sea," 7 April 1977, 4-5; accessed 2 February 2011, www.nal.usda.gov/speccoll/findaids/agentorange.

349 National Agricultural Library Special Collections, Alvin L. Young Collection on Agent Orange, Pamela W. Smith, "Agent Orange: Veterans' Complaints Concerning Exposure to Herbicides in South Vietnam Issue Brief Number IBS0040," Science Policy Research Division, September 6 1979, 7-8, accessed February 2, 2011, www.nal.usda.gov/speccoll/findaids/agentorange.

350 Col. Donald Kane, Note to author, 6 Nov 13.

351 National Agricultural Library Special Collections, Alvin L. Young Collection on Agent Orange, Albert N. Rhodes, "Herbicide Orange Monitoring Program Addendum I, January 1980 – February 1985," Engineering & Services Laboratory, Air Force Engineering & Services Center, Tyndall AFB, Florida, May 1985, 2, accessed February 3, 2011, www.nal.usda.gov/speccoll/findaids/agentorange/index.htm.

352 National Agricultural Library Special Collections, Alvin L. Young Collection on Agent Orange, Colonel Walter J. Rabe, Memorandum "Reevaluation Review of Draft USAF SON 2-81," attachment "Draft USAF SON #2-81 Statement of Operational Need for Reclamation of Herbicide Orange Contaminated Sites," 7 April 1981, accessed February 3, 2011, www.nal.usda.gov/speccoll/findaids/agentorange/index.htm; National Agricultural Library Special Collections, Alvin L. Young Collection on Agent Orange, Albert N. Rhodes, "Herbicide Orange Monitoring Program Addendum I, January 1980 – February 1985," Engineering & Services Laboratory, Air Force Engineering & Services Center, Tyndall AFB, Florida, May 1985, 3, accessed 3 February 2011, www.nal.usda.gov/speccoll/findaids/agentorange/index.htm.

353 "Environics Laboratory," *Air Force Engineering & Services Update*, Vol 1 No 1 August 1988, 6; "AFESC Completes Gulfport Cleanup Project," *Air Force Engineering & Services Update*, Vol 1, No 1, January 1989, 2.

354 Maj. Gen. Maurice R. Reilly, "Air Force Construction Program," *TME*, Vol 64, No 419, May-June 1972, 169.

355 Col. Elo Mussetto, "Air Force Regional Civil Engineer," *ESQ*, November 1979, 34-36.

356 "Family Housing," *TME*, Vol 67, No 439, September-October 1975, 300.

357 Lester H. Henriksen and Gary D. Vest AIP, "Mission Effectiveness & Base Livability A Hypothesis," *ESQ,* Vol 17, No 4, November 1976, 5-6.

358 Glen R. Schauer, RA "Air Force Reshapes Man's Castle," *ESQ*, Vol 18, No 2, May 1977, 30.

359 Ibid., 31.

360 AFESC History, CY 1982; AFESC History, CY 1985; Lt. Col. David F. Honeycutt, "TLFs Make Moving Less Costly," *ESQ*, Vol 25, No 2, Summer 1984, 30.

361 H. Perry Sullivan, ed., "A Change at the Top," *ESQ*, Summer 1982, 30.

362 Air Staff Histories, 1984 January – June; Air Staff Histories, 1984 July-December.

363 John C. Lonnquest and David Winkler, *To Defend and Deter: The Legacy of the United States Cold War Missile Program*, U.S. Army Construction Engineering Research Laboratories, Champaign, Illinois, Sponsored by Department of Defense Legacy Resource Management Program, 1996, 125; Lt. Col. Thomas L. Bozarth, "A Super Project Special Report: It is the…M-X Weapon System…an Essential Element of Strategic Deterrence, *Engineering & Services Quarterly*, Vol 21, No 2, May 1980, 3; "AFRCE MX Established at Norton AFB," *Engineering & Services Quarterly*, Vol 21, No 2, May 1980, 7; Office of the Historian HQ SAC, "Snark to Peacekeeper A Pictorial History of Strategic Air Command Missiles," HQ SAC, Offutt Air Force Base, Nebraska, 1990, 43.

364 "Air Force Regional Civil Engineer History," AHO; John C. Lonnquest and David Winkler, *To Defend and Deter: The Legacy of the United States Cold War Missile Program*, U.S. Army Construction Engineering Research Laboratories, Champaign, Illinois, Sponsored by Department of Defense Legacy Resource Management Program, 1996, 125; "AFRCE MX Established at Norton AFB," *Engineering & Services Quarterly*, Vol 21, No 2, May 1980, 7.

365 Lt. Col. Thomas L. Bozarth, "A Super Project Special Report: It is the…M-X Weapon System…an Essential Element of Strategic Deterrence," *Engineering & Services Quarterly*, Vol 21, No 2, May 1980, 6.

366 E-mail, Col. William R. Sims and Brig. Gen. Michael A. McAuliffe to Author, 26 Nov 13, AHO.

367 Ibid.; Air Staff History, Environmental Planning Division, Jan-Jun 1984, np, AHO.

368 John C. Lonnquest and David Winkler, *To Defend and Deter: The Legacy of the United States Cold War Missile Program*, U.S. Army Construction Engineering Research Laboratories, Champaign, Illinois, Sponsored by Department of Defense Legacy Resource Management Program, 1996, 125-126.

369 "Air Staff Histories, Office of the Special Assistant, July-December 1981," n.p., AHO.

370 Ibid.

371 Lt. Col. Thomas L. Bozarth, "A Super Project Special Report: It is the…M-X Weapon System…an Essential Element of Strategic Deterrence, *Engineering & Services Quarterly*, Vol 21, No 2, May 1980, 5.

372 "Air Staff Histories, Office of the Special Assistant, July-December 1981,"n.p., AHO.

373 John C. Lonnquest and David Winkler, *To Defend and Deter: The Legacy of the United States Cold War Missile Program*, U.S. Army Construction Engineering Research Laboratories, Champaign, Illinois, Sponsored by Department of Defense Legacy Resource Management Program, 1996, 125-126.

374 Edgar Ulsamer, "Gains and Gaps in Strategic Forces," *Air Force Magazine*, September 1985, 126,132.

375 John C. Lonnquest and David Winkler, *To Defend and Deter: The Legacy of the United States Cold War Missile Program*, U.S. Army Construction Engineering Research Laboratories, Champaign, Illinois, Sponsored by Department of Defense Legacy Resource Management Program, 1996, 125-126; Alwyn T. Lloyd, *A Cold War Legacy: A Tribute to Strategic Air Command 1946 - 1992*, Pictorial Histories Publishing Company, Inc., Missoula, Montana, 1999, 631-633; Lauren Hasinger, Senior Airman, "Air Force Says farewell to most powerful ICBM," accessed 17 March 2009, http://www.af.mil/news/story.asp?storyID=123011829; 2d Lt. Joshua S. Edwards, "Peacekeeper Missile Mission Ends During Ceremony," USAF Print News, 20 September 2005, n.p.

376 History of the Directorate of Engineering and Services, DCS/L&E, 1 Jul-31 Dec 1985, Plans Division, np; History of the Directorate of Engineering and Services, DCS/L&E, 1 Jul-31 Dec 1984, Environmental Division, np; "Secretary Rice Issues Air Force Statement," CE Update, Vol 4, No 1, March 1992, 5.

377 Alwyn T. Lloyd. *A Cold War Legacy: A Tribute to Strategic Air Command 1946 - 1992*. Pictorial Histories Publishing Company, Inc., Missoula, Montana, 1999, 633; Office of the Historian HQ SAC, "Snark to Peacekeeper A Pictorial History of Strategic Air Command Missiles," HQ SAC, Offutt Air Force Base, Nebraska, 1990, 43, 47, 49.

378 President George H. W. Bush, "Address to the Nation on Reducing United States and Soviet Nuclear Weapons," George Bush Presidential Library and Museum, College Station, Texas, 27 September 1991, Electronic document, available at http://bushlibrary.tamu.edu, accessed May 2011.

379 TSgt. Merrie Shilter, "Air Force Pushes to Have SLC-6 Ready by October," *Air Force News Service*, Kelly AFB, Texas, n.d., 7, AHO; William R. Doemer and Anastasia Toutexis, "Space: New Pad for the Space Shuttle," *Time*, 5 March 1984, n.p., accessed February 14, 2011, www.time.com.

380 Lt. Col. Thomas L. Bozarth, "Space Shuttle Update: Into the Construction Phase," *Air Force Engineering & Services*, Vol 21, No 2, May 1980, 8.

381 William R. Doemer and Anastasia Toufexis, "Space: New Pad for the Space Shuttle," *Time*, 5 March 1984, n.p., accessed February 14, 2011, www.time.com. The engineering complexity of the design for the facilities was recognized by the The American Council of Engineering Companies on 18 April 1985 when it awarded Sverdrup & Parcel and Asssociates, of St. Louis, Missouri, their "Grand Conceptor Award," for their role in the "Space Shuttle Launch Complex, Vandenberg Air Force Base California." This annual award was the single and highest award among the 110 awards given for projects across the United States at that ceremony.

382 William R. Doemer and Anastasia Toufexis, "Space: New Pad for the Space Shuttle," *Time*, 5 March 1984, n.p., accessed February 14, 2011, www.time.com.

383 Lt. Col. Thomas L. Bozarth, "Space Shuttle Update: Into the Construction Phase," *Air Force Engineering & Services*, Vol 21, No 2, May 1980, 8.

384 William R. Doemer and Anastasia Toutexis, "Space: New Pad for the Space Shuttle," *Time*, 5 March 1984, n.p., accessed February 14, 2011, www.time.com; TSgt. Merrie Shilter, "Air Force Pushes to Have SLC-6 Ready by October," *Air Force News Service*, Kelly AFB, Texas, n.d., 10, AHO.

385 William R. Doemer and Anastasia Toutexis, "Space: New Pad for the Space Shuttle," *Time*, 5 March 1984, n.p., accessed February 14, 2011, www.time.com.

386 TSgt. Merrie Shilter, "Air Force Pushes to Have SLC-6 Ready by October," *Air Force News Service*, Kelly AFB, Texas, n.d., 9, AHO.

387 TSgt. Merrie Shilter, "Air Force Pushes to Have SLC-6 Ready by October," *Air Force News Service*, Kelly AFB, Texas, n.d., 9-10, AHO; William R. Doemer and Anastasia Toutexis, "Space: New Pad for the Space Shuttle," *Time*, 5 March 1984, n.p., accessed February 14, 2011, www.time.com.

388 TSgt. Merrie Shilter, "Air Force Pushes to Have SLC-6 Ready by October," *Air Force News Service*, Kelly AFB, Texas, n.d., 10, AHO.

389 Ibid., 11.

390 Ibid., 15.

391 TSgt. Merrie Shilter, "Air Force Pushes to Have SLC-6 Ready by October," *Air Force News Service*, Kelly AFB, Texas, n.d., 13, AHO; "Colonel Gibson 'Slick Six' Project Officer Retires in June," *Air Force Engineering & Services Update*, Vol 2, No 3 May 1990, 13.

392 HQ AFESC, "Final Report on Project Touchdown: A Comprehensive Evaluation of Northrup Strip Airfield, White Sands Missile Range, As a Landing Site for the Space Shuttle Orbiter," prepared for National Aeronautics and Space Administration , February 1981, 1.

393 HQ AFESC, "Final Report on Project Touchdown: A Comprehensive Evaluation of Northrup Strip Airfield, White Sands Missile Range, As a Landing Site for the Space Shuttle Orbiter," prepared for National Aeronautics and Space Administration, February 1981,1; "Worth Noting: Hard Surface Assured for Columbia Landing," *ESQ*, Vol 23, No 1, Spring 1982, 40; Maj. James I. Clark, "Project Touchdown: A Comprehensive Evaluation of the Northrup Strip Airfield, White Sands Missile Range, as a Landing Site for the Space Shuttle Orbiter," prepared for National Aeronautics and Space Administration, July 1979, 1.

394 Maj. James I. Clark, "Project Touchdown: A Comprehensive Evaluation of the Northrup Strip Airfield, White Sands Missile Range, as a Landing Site for the Space Shuttle Orbiter," prepared for National Aeronautics and Space Administration July 1979; "Worth Noting: Hard Surface Assured for Columbia Landing," *ESQ*, Vol 23, No 1 Spring 1982, 40.

395 Maj. James I. Clark, "Project Touchdown: A Comprehensive Evaluation of the Northrup Strip Airfield,

White Sands Missile Range, as a Landing Site for the Space Shuttle Orbiter," prepared for National Aeronautics and Space Administration July 1979, 5-6.

396 Ibid., 7.

397 Maj. James I Clark, "Project Touchdown: Lending a Hand," *ESQ*, Vol 21, No 2, May 1980, 11.

398 Maj. James I. Clark, "Project Touchdown: A Comprehensive Evaluation of the Northrup Strip Airfield, White Sands Missile Range, as a Landing Site for the Space Shuttle Orbiter," prepared for National Aeronautics and Space Administration July 1979, 9-10; Maj. James I Clark, "Project Touchdown: Lending a Hand," *ESQ*, Vol 21, No 2, May 1980, 12.

399 Maj. James I. Clark, "Project Touchdown: A Comprehensive Evaluation of the Northrup Strip Airfield, White Sands Missile Range, as a Landing Site for the Space Shuttle Orbiter," prepared for National Aeronautics and Space Administration, July 1979, 4; 31-32.

400 HQ AFESC, "Final Report on Project Touchdown: A Comprehensive Evaluation of Northrup Strip Airfield, White Sands Missile Range, As a Landing Site for the Space Shuttle Orbiter," prepared for National Aeronautics and Space Administration, February 1981, 2.

401 "Worth Noting: Hard Surface Assured for Columbia Landing," *ESQ*, Vol 23, No 1, Spring 1982, 40; AFESC, "Air Force Engineering and Services Center History," 1981, 11, AHO.

402 Norman Polmar, *Strategic Air Command: People, Aircraft, and Missiles*, The Nautical and Aviation Publishing Company of America, Inc., Annapolis, Maryland, 1979, 201-203; Office of the Historian, Headquarters Strategic Air Command, *From Snark to Peacekeeper: A Pictorial History of Strategic Air Command Missiles*, Headquarters Strategic Air Command, Offutt AFB, Nebraska, 1990, 69.

403 Maj. Gerald L. Robinson, Capt. S.M. Tully, PE, and Capt. B.E. Wilson, "Air Launched Cruise Missile Construction Program," *Engineering & Services Quarterly*, Vol 2, No 2, May 1980, 28, 37; Col. William R. Andrews, Jr. and Bob Hipschman, "ALCM Beddown: More Construction for the Money Through Cooperation," *ESQ*, Vol 25, No 1, Spring, 1984, 28-29; Capt. Michael B. Perini, "The Still Mighty Eighth," *Air Force Magazine*, December 1982, n.p.

404 Maj. Gerald L. Robinson, Capt. S.M. Tully, PE, and Capt. B.E. Wilson, "Air Launched Cruise Missile Construction Program," *Engineering & Services Quarterly*, Vol 2, No 2, May 1980, 28, 37; Col. William R. Andrews, Jr. and Bob Hipschman, "ALCM Beddown: More Construction for the Money Through Cooperation," *ESQ*, Vol 25, No 1, Spring, 1984, 28-29; Capt. Michael B. Perini, "The Still Mighty Eighth," *Air Force Magazine*, December 1982, n.p.

405 Donald J. Horan, Director Procurement, Logistics, and Readiness Division, Letter to Senator Sasser, 30 September 1982, *Cost Overrun on the Aeropropulsion Systems Test Facility*, AHO.

406 Ibid.

407 Maj. Gen. Clifton D. Wright, Jr., "Oral History Interview," interview by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, May 2002, 73-74.

408 Ibid.

409 Maj. Gen. William D. Gilbert, "Oral History Interview," interview by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, September 2002, 79.

410 Air Staff History 1976, AHO; "Aeropropulsion Systems Test Facility," U.S. Air Force Fact Sheet, accessed 12 November 2008, http://www.arnold.af.mil/library/factsheets/; Department of Defense, "NASA Aeronautics Facilities Critical to DoD Report to Congress," January 2007, 3.

411 Arnold Air Force Base, "Aeropropulsion Systems Test Facility," U.S. Air Force Fact Sheet, accessed 12 November 2008, http://www.arnold.af.mil/library/factsheets/.

412 Lt. Col. Joseph J. Loncki, "On Time and Under Budget: Construction of the Consolidated Operations Space Center," *ESQ*, Vol 26, No 4, Winter 1985/86, 4-7.

413 Gen. James V. Hartinger, "The Air Force Space Command: An Update," (based on an address by Gen. James V. Hartinger to the Air Force Engineering and Services Conference on Programming, Jan. 30, 1984, Peterson AFB, CO), *ESQ*, Vol 25, No 2, Summer 1984, 6.

414 Lt. Col. Joseph J. Loncki, "On Time and Under Budget: Construction of the Consolidated Operations Space Center," *ESQ*, Vol 26, No 4, Winter 1985/86, 4-7.

415 Ibid., 6-7.

416 H. Perry Sullivan, Jr., "Profiles in Leadership, Interviewing a man who got the job done: J.B. Cole Retires at AFCEE," *The U.S. Air Force Civil Engineer*, Vol 1, No 10, December 1993, 13.

417 Capt. Patrick M. Coullahan, "Maintaining Top Cover for America," *ESQ*, Vol 22, No 4, Winter 1981-1982, 40-43; John Haile Cloe, Top Cover for America: The Air Force in Alaska, 1920-83, 239-40.

418 "Arctic Renewal," Air Force Engineering and Services Quarterly, Vol 24, No 2, Summer 1993, 8-11; Capt. Patrick M. Coullahan, "Maintaining Top Cover for America," *ESQ*, Vol 22, No 4, Winter 1981-1982, 40-43.

419 Frank N. Schubert, *Building Air Bases in the Negev: The U.S. Army Corps of Engineers in Israel, 1979-1982*, Office of History, Corps of Engineers, Washington, D.C., 1992, 7-16; Maj. Gen. William D. Gilbert, (USAF, Retired) "Oral History Interview," interview by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, September 2002, 73-74.

420 "Israeli Air Base Construction Program" Air Staff History January-June 1979, AHO.

421 "IAB Program Procedures for Program Conclusion Program Management," AHO.

422 Maj. Gen. William D. Gilbert, (USAF, Retired), "Oral History Interview," interview by Lois E. Walker,

HQ AFCESA, Tyndall AFB, Florida, September 2002, 73-74.

423 Harry P. Rietman, "Oral History Interview," interview by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, November 2004, 75.

424 "IAB Program Procedures for Program Conclusion Program Management," AHO.

425 Ibid.

426 Col. Clarence D. Gilkey, "Fast Tracking the Israeli Air Bases," *TME* Vol 61, No 469, October 1980, 316; Capt. Karsten H. Rothenberg, "Israeli Air Base Construction Program" *ESQ* Vol 21, No 2, May 1980, 13; "Israeli Air Base Construction Program" Air Staff History January-June 1979, AHO; Frank N. Schubert, *Building Air Bases in the Negev: The U.S. Army Corps of Engineers in Israel*, 1979-1982, Office of History, Corps of Engineers, Washington, D.C., 1992, 125.

427 "IAB Program Procedures for Program Conclusion Program Management," AHO.

428 Charles F. Lewis, AICP, "Point Paper on Operational and Development Concepts of Israeli Air Force (IAF) Bases," 5 April 1989, AHO; Maj. Gen. Clifton D. Wright, Jr. (USAF, Retired) "Oral History Interview," interview by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, May 2002, 76-77.

429 Frank N. Schubert, *Building Air Bases in the Negev: The U.S. Army Corps of Engineers in Israel*, 1979-1982, Office of History, Corps of Engineers, Washington, D.C., 1992, 129

430 "Israeli Air Base Construction Program," Air Staff History July-December 1980, AHO.

431 "Israeli Air Base Construction Program" AHO; Air Staff History July-December 1982, AHO; Frank N. Schubert, *Building Air Bases in the Negev: The U.S. Army Corps of Engineers in Israel*, 1979-1982, Office of History, Corps of Engineers, Washington, D.C., 1992, 230-32.

432 SAME Medals Honor USAF Generals," *ESQ*, Vol 23 No 2, Summer 1982, 18; E-mail, Karsten H. Rothenberg to Author, 20 Dec 13, AHO.

433 Lt. Col. Harry W. Glaze and Lt. Col. Larry G. Garrison, "The Saudi Arabian Construction Program," *ESQ*, Vol 21, No 2, May 1980, 20-23; HQ AFLC/DE "History of Engineering and Services in Air Force Logisitics Command," Dec 1985, AHO; Robart P. Grathwol and Donita M. Moorhus, *Bricks, Sand, and Marble: U.S. Army Corps of Engineers Construction in the Mediterranean and Middle East, 1947-1991*, Center of Military History and Corps of Engineers, Washington DC, 2009, 379-84.

434 Air Staff History July-December 1981, AHO; Lt. Col. Harry W. Glaze and Lt. Col. Larry G. Garrison, "The Saudi Arabian Construction Program," *ESQ*, Vol 21, No 2, May 1980, 20-23.

435 Air Staff History, Jan-Jun 1982, Office of Special Assistant, 101-2, AHO; Maj. Gen. Clifton D. Wright, Jr. (USAF, Retired), "Oral History Interview," interview by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, May 2002, 77.

436 Nomination for Newman Medal: Colonel Karsten H. Rothenberg, 31 Oct 1990, Files of the AFCESA History Office, Tyndall AFB, Florida; Capt. Phil Melancon, HQ AFMC, CEOO, "What is AFMC all about?" CE Update, Vol 4 No 3, Sep 1992, 16-21.

437 CMSgt. Joseph H. Smith and CMSgt. Wade H. Grimm, "Project Peace Pharoah Mobility at its Best," *Air Force Engineering and Services Quarterly* Vol 21, No 3, August 1980, 17.

438 Ibid., 16-17.

439 .Robert P. Grathwol and Donita M. Moorhus, Bricks, Sand, and Marble: U.S. Army Corps of Engineers Construction in the Mediterranean and Middle East, 1947-1991, Center of Military History and Corps of Engineers, Washington D.C., 2009, 547; History of the Air Force Engineering and Services Center, 1 Jan-31 Dec 1982, 57, AHO.

440 Maj. Gen. Joseph A. Ahearn (USAF, Retired), "Oral History Interview," interview by Dr. Douglas H. Merkle and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, March 2008, 64.

441 Ibid., 75.

442 Ibid., 75-76.

443 Ibid., xi.

444 Ibid., 74.

445 Maj. Jack T. Baker, "The Ground-launched Cruise Missile in Europe, An International Challenge," *Engineering & Services Quarterly*, Vol 25, No 1, Spring 1984, 32-33.

446 Dr. Jack Baker, *Welcome to Comiso*, CreateSpace Independent Publishing Platform, North Charleston, SC, 2013, 97-130; Maj. Jack T. Baker, "The Ground-launched Cruise Missile in Europe, An International Challenge," *Engineering & Services Quarterly*, Vol 25, No 1, Spring 1984, 32-33; Maj. Jack T. Baker and Sgt. Lea Blake, "COSMISO: GLCM at the Crossroad of History," *Engineering & Services Quarterly*, Summer 1983, 33-34.

447 Lt. Col. Charles Lindbergh, PE, "USAFE Operational Readiness: A challenge to Military Engineering," Engineering & Services Quarterly, Vol 18, No 1, Nov 1977, 18-22.

448 Maj. Ulrich H. Lettau, "COBs in Europe," *AFCE* Vol 22, No 2, Summer 1981, 20-21.

449 Christopher J. Bowie, "The Lessons of Salty Demo," *Air Force Magazine*, March 2009, accessed September 30, 2010, www.airforce-magazine.com.

450 Jack Neufeld, Air Staff History, Chapter on Logistics and Engineering, 1988, 15, AHO.

451 Lt. Col. Clifton T. Windham and Joseph H. Smith, "Bare Base: A New Frontier," *ESQ*, Vol 24, No 4, Winter 1983, 24-26.

452 Joseph H. Smith, "Oral History Interview," interview by Lois E. Walker, HQ AFCESA, Tyndall AFB,

Florida, November 2004, 38, 40, 42; Capt. Kenneth M. Weaver, "An Historical Analysis of the Air Force's Bare Base Concept and Equipment," Thesis, School of Systems and Logistics of AFIT, Air University, 1989, 23.

453 Weekly Activity Report, AFESC Director of Readiness, 11 Sep 91 and 27 Nov 91, AHO.

454 Joseph H. Smith, "Oral History Interview," interview by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, November 2004, 38, 40, 42.

455 Department of the Air Force, Air Force Pamphlet 10-219, Bare Base Conceptual Planning Guide, Vol 5 1 June 1996, 9; Capt. Kenneth M. Weaver, "An Historical Analysis of the Air Force's Bare Base Concept and Equipment," Thesis, School of Systems and Logistics of AFIT, Air University, 1989, 17, 24-45.

456 Capt. Kenneth M. Weaver, "An Historical Analysis of the Air Force's Bare Base Concept and Equipment," Thesis, School of Systems and Logistics of AFIT, Air University, 1989, 24-45.

457 Jack Neufeld, Air Staff History, Chapter on Logistics and Engineering, 1988, 15, AHO.

458 Joseph H. Smith, "Oral History Interview," interview by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, November 2004, 44.

459 Eugene E. Peer and Maj. Richard A. Thompson, "History of the Civil Engineering School," June 1979, AHO.

460 Lt. Col. Marvin T. Howell, PE, "Palace Blueprint: Six Years Later," *ESQ*, Vol 17, No 2, May 1976, 31-32.

461 Maj. Richard M. Bierly, PE, "Readiness is People," *ESQ*, Vol 18, No 4, November 1977, 14, 37.

462 Lt. Col. Ronald E. Knipfer, PE and Lt. Col. Patrick J. Sweeney, PE, "AFIT's Facilities Management Program," *ESQ*, Vol 18, No 3, August 1977, 24.

463 Ibid.

464 Maj. Joe Munter and Maj. Allan E.M. Tucker, "GEM: Decade of Progress," *ESQ*, Vol 25, No 3, Fall 1984, 8-10.

465 H. Perry Sullivan, Jr., "An Interview: ESQ talks with the Commandant of the Air Force Institute of Technology (Brig. Gen. James T. Callaghan)," *ESQ*, Vol 25, No 3, Fall 1984, 4-7.

466 Maj. Roger S. Alexander, Program Manager, "EWI: What Does it Mean?," *ESQ*, Vol 22, No 3, Fall 1981, 31-32; Capt. Thomas M. Riggs, "EWI with DFW," *ESQ*, Vol 22, No 3, Fall 1981, 35.

467 Col. Marshall N. Nay, Jr., "To PhD or not to…, is that your Question?," *Air Force and Engineering & Services*, Vol 27, No 2, Summer 1986, 30-31.

468 Harry P. Rietman, "Oral History Interview," interview by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, November 2004, iii, 89; Charles T. Johnson, "E&S Civilian Career Management Program: Civilian Careers," *ESQ*, Vol 24, No 3, Fall 1982, 42-43.

469 Harry P. Rietman, "Oral History Interview," interview by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, November 2004, 90.

470 Charles T. Johnson, "E&S Civilian Career Management Program: Civilian Careers," *ESQ*, Vol 24, No 3, Fall 1982, 42-43.

471 Ibid.

472 Ibid., back cover.

473 H. Perry Sullivan, Jr., "An Interview with the Associate Director Harry P. Rietman," *ESQ*, Vol 24, No 3, Fall 1983, 22-25.

474 Charles T. Johnson, "E&S Civilian Career Management Program: Civilian Careers," *ESQ*, Vol 23, No 3, Fall 1982, 42-43.

475 "Directorate of Engineering and Services Current Emphasis," *ESQ*, Vol 25, No 2, Summer 1984, 13.

476 Ibid., No 3, Fall 1984, 34.

477 Charles T. Johnson, "E&S Civilian Career Management Program: Civilian Careers," *ESQ*, Vol 23, No 3, Fall 1982, 42-43.

478 "Directorate of Engineering and Services Current Emphasis," *ESQ*, Vol 25, No 4, Winter 1984-1985, 34.

479 "Directorate of Engineering and Services Current Emphasis," *ESQ*, Vol 26, No 2, Summer 1985, 38.

480 "Directorate of Engineering and Services Current Emphasis," *ESQ*, Vol 27, No 2, Summer 1986, 25.

481 "Directorate of Engineering and Services Current Emphasis," *ESQ*, Vol 26, No 2, Summer 1985, 38; "Directorate of Engineering and Services Current Emphasis," *ESQ*, Vol 26, No 3, Fall 1985, 22; Charles T. Johnson, "E&S Civilian Career Management Program: Civilian Careers," *ESQ*, Vol 23, No 3, Fall 1982, 42-43; "Directorate of Engineering and Services Current Emphasis," *ESQ*, Vol 26, No 4, Winter 1985-1986, 35.

482 "Directorate of Engineering and Services Current Emphasis," *ESQ*, Vol 26, No 4, Winter 1985-1986, 35.

483 "Directorate of Engineering and Services Current Emphasis," *ESQ*, Vol 26, No 3, Fall 1985, 23.

484 Col. Robert F. Darden, Jr., "Not Under a Shade Tree," *ESQ,* Vol 19, No 3, August 1978, 7; Capt. Deal H. Bayless, "Electronic Courses Changed at Sheppard," *E&S Update* Vol 2, No 2, Mar 90, 10; Capt. James Rayner, "Understanding Technical Training for the Civil Engineering Community," *E&S Update*, Jan 1989, 9; A Brief History of the 82d Training Wing and Sheppard AFB, accessed 18 Jul 12, http://www.sheppard.af.mil/shared/media/document/AFD-120424-046.pdf.

485 Douglas E. Courchene, *Pioneers with Intent, Memoirs of an Air Force Fire Fighter*, Air Force Civil Engineer Support Agency, Tyndall AFB July 2003, 61.

486 Ibid.; Maj. Robert L. Gott, "Fire Protection Training School Program," *ESQ*, Vol 19, No 3, August 1978, 12.

487 Maj. Gen. William D. Gilbert, "From the Director: The First Priority Mission," *ESQ*, Vol 20, No 4, November 1979, n.p.

488 Maj. Max W. Day, PE and Lt. Col. George T. Murphy, "The Wartime Role of Engineering and Services," *ESQ*, Vol 20, No 4, November 1979, 18-19.

489 "From the Director, The First Priority Mission," *Engineering & Services Quarterly*, November 1979, n.p.

490 Maj. Max W. Day, PE and Lt. Col. George T. Murphy, "The Wartime Role of Engineering and Services," *ESQ*, Vol 20, No 4, November 1979, 18-19.

491 Conversation between Col. Roy G. Kennington and Dr. Ronald B. Hartzer, 14 Dec 2010.

492 Maj. Max W. Day, PE and Lt. Col. George T. Murphy, "The Wartime Role of Engineering and Services," *ESQ*, Vol 20, No 4, November 1979, 20-21.

493 Lt. Col. Roy G. Kennington, "Services into the 1980s," *ESQ*, Vol 21, No 1, February 1980,10.

494 Maj. Max W. Day, PE and Lt. Col. George T. Murphy, "The Wartime Role of Engineering and Services," *ESQ*, Vol 20, No 4, November 1979, 21.

495 Lt. Col. Roy G. Kennington, "Services into the 1980s," *ESQ*, Vol 21, No 1, February 1980,10.

496 Maj. Gen. Clifton D. Wright, Jr. (USAF, Retired), "Oral History Interview," interview by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, May 2002, 68.

497 Lt. Col. Willis O. Pickering, Jr., "Prime RIBS Wartime Readiness," *ESQ*, Vol 23, No 3, Fall 1982, 13-14.

498 Lt. Col. Willis O. Pickering, Jr., "Prime RIBS Wartime Readiness," *ESQ*, Vol 23, No 3, Fall 1982, 13-14.

499 Ibid., 14.

500 Ibid., 12.

501 Ibid.; Maj. Max W. Day and Lt. Col. George T. Murphy, "Prime BEEF and Prime RIBS, The Wartime Role of Engineering and Services," *Engineering & Services Quarterly*, Vol 20, No 4, November 1979.

502 Capt. Pat Coullahan, "Civil Engineering Wartime Manpower Study," *ESQ*, Vol 23, No 2, Summer 1982, 29; Lt. Matthew Durham, "History of the Air Force Engineering and Services Center," 1 Jan-31 Dec 1982, 53-55; HQ AFESC/DEO, "Prime BEEF Team Restructuring, 10 Nov 1983, Files of the AFCESA History Office, Tyndall AFB, Florida.

503 Maj. Robert J. Bittner, "The New Prime BEEF Mobility Team Structure, A Flexible Approach," *ESQ*, Vol 25, No 2, Summer 1984, 34-38.

504 Staff Summary Sheet, Col. Warren C. Dickerson, Director of Readiness, AFESC, "Restructuring of Civil Engineering Wartime Mobility Forces," nd; Report, AFESC Directorate of Readiness, "Prime BEEF Combat Support Team Implementation Guidance," 1 Nov 1986; AHO.

505 CMSgt. Joseph H. Smith, "Dynamic Role of Readiness Training," *Engineering & Services Quarterly*, Vol 21, No 3, August 1980, 3-4.

506 Ibid., 4.

507 Ibid., 5.

508 Air Reserve Forces Review Magazine/Air Reserve Forces Review (ARFR), November 1972, 10.

509 Charles Joseph Gross, *The Air National Guard and the American Military Tradition*, Historical Services Division, National Guard Bureau, Washington, D.C., 1995, 115.

510 Air National Guard Readiness Center, Survey of the Architectural and Archeological Cultural Resources at the Virginia Air National Guard Installations at the Richmond International Airport, Henrico County and the State Military Reservation, Camp Pendleton, City of Virginia Beach, Virginia, prepared by R. Christopher Goodwin & Associates, Inc., Frederick, Maryland, 2007, 4-24.

511 Charles Joseph Gross, *The Air National Guard and the American Military Tradition*, Historical Services Division, National Guard Bureau, Washington, D.C., 1995, 114-115.

512 James Penn, "Engineering and Services Reservists…Ready Now!" *ESQ*, Vol 26, No 2, Summer 1985, 33.

513 Ibid.

514 Col. James P. Penn, "On the AFRES Menu- Prime RIBS," *ESQ*, Vol 22, No 2, Summer 1981, 27.

515 Lt. Col. James P. Blanco, "Prime RIBS: Realistic Practice is the Key," *ESQ*, Vol 27, No 2, Summer 1986, 14-15.

516 James Penn, "Engineering and Services Reservists…Ready Now!" *ESQ*, Vol 26, No 2, Summer 1985, 33.

517 Ibid.

518 Dick George, "'Home Away from Home'," *ESQ*, Vol 26, No 2, Summer 1985, 30.

519 Air National Guard Readiness Center, Survey of the Architectural and Archeological Cultural Resources at the Virginia Air National Guard Installations at the Richmond International Airport, Henrico County and the State Military Reservation, Camp Pendleton, City of Virginia Beach, Virginia, prepared by R. Christopher Goodwin & Associates, Inc., Frederick, Maryland, 2007, 6-11.

520 James Penn, "Engineering and Services Reservists…Ready Now!" *ESQ*, Vol 26, No 2, Summer 1985,

31-33.

521 Ibid., 33.

522 Lt. Col. James P. Penn, "Bulldozer University? Nobody Laughs Anymore!" *ESQ*, Vol 21, No 3, August 1980, 18-19.

523 H. Perry Sullivan, Jr. "Whatever Happened to Bulldozer U?" *ESQ*, Vol 26, No 1, Spring 1985, 26-27.

524 H. Perry Sullivan, Jr. "Whatever Happened to Bulldozer U?" *ESQ*, Vol 26, No 1, Spring 1985, 26-27.

525 Capt. Patrick M. Coullahan and CMSgt. Robert B. Wertman, "Jack Frost 79," *ESQ*, Vol 21, No 3, August 1980, 6-7.

526 Ibid., 8.

527 Ibid.

528 Col. Darrell G. Bittle, "Air Base Survivability," *ESQ*, Vol 23, No 1, Spring 1982, 7-13.

529 Col. Darrell G. Bittle, "Air Base Survivability," *ESQ*, Vol 23, No 1, Spring 1982, 7-13.

530 Ibid., 12.

531 CMSgt. Dave Brown, CMSgt. (Retired) Marshall B. "Doc" Dutton, SMGt. Marshall G. "Baby Doc" Dutton, "Air Force EOD's Move, USAF Exploded Ordnance Disposal (EOD), From Maintenance to Civil Engineering," n.d., AHO.

532 Col. Darrell G. Bittle, "Air Base Survivability," *ESQ*, Vol 23, No 1, Spring 1982, 12.

533 Maj. Gen. Joseph A. Ahearn (USAF, Retired), "Oral History Interview," interview by Dr. Douglas H. Merkle and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, March 2008, 72.

534 Maj. Gen. Clifton D. Wright, Jr. (USAF, Retired), "Oral History Interview," interview by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, May 2002, 99.

535 Maj. Gen. James E. McCarthy, "Oral History Interview," interview by Dr. Douglas H. Merkle and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, June 2005, 46.

536 Ibid.

537 Maj. Robert L. Bell, "Rapid Runway Repair…a Civil Engineering Mission" *AFCE* Vol 16, No 1, February 1975, 22.

538 Joseph H. Smith, "Oral History Interview," interview by Lois E. Walker, Contingency Support Directorate AFCESA, Tyndall AFB, Florida, November 2004, 45; "Technical Review of Rapid Runway Repair History," October 1, 1986, AHO.

539 Lt. Col. Robert E. Boyer and Philip T. Nash, "North Field Meeting the Triple R Challenge," *ESQ*, Vol 22, No 2, Summer 1981, 18.

540 Tidal McCoy, "Task One: Air Base Operability," *Armed Forces Journal International,* Sept 1987, 54.

541 "Position Paper on Functional Realignment of Explosive Ordnance Disposal (EOD) under Engineering and Services," AHO.

542 CMSgt. Dave Brown, CMSgt. (Ret) Marshall B. "Doc" Dutton, SMGt Marshall G. "Baby Doc" Dutton, "Air Force EOD's Move, USAF Exploded Ordnance Disposal (EOD), From Maintenance to Civil Engineering," n.d., AHO.

543 Dr. Ronald B. Hartzer, "Airfield Damage Repair: The Beginning," *AFCE*, Vol 20, No 2, 2012, 28-31; Joseph H. Smith, "Oral History Interview," interview by Lois E. Walker, Contingency Support Directorate AFCESA, Tyndall AFB, Florida, November 2004, 47.

544 "Fiberglass Mats Delivered, Tactical Air Warfare Center Accepts Folded FG Mats" *TME*, Vol 82, No 528, August 1990, 53.

545 Sgt Marvin Gardner, "Rodeo!" *ESQ*, Vol 25, No 4, Winter 1984/85, 24-28; Dr. Ronald B. Hartzer,"History of Readiness Challenge," AHO

546 Dr. Ronald B. Hartzer, "History of Readiness Challenge," AHO.

547 Ken Perrotte, "AFLC Prime BEEF Really Cooks at Air Force Competition," *ESQ*, Vol 27, No 2, Summer 1986, 18-20; "History of Readiness Challenge," AHO.

548 "History of Readiness Challenge," AHO.

549 Ibid.

550 Ibid.

551 Capt. R.A. Torgerson and Maj. K.A. Kolz, "A Horse of a Unique Color," *Engineering & Services Quarterly*, Vol 21, No 3, August 1980, 24-25; "RED HORSE Unit Histories," RED HORSE Association, accessed April 1, 2009, www.redhorseassociation.org/unithistories819.html.

552 Col. Dibrell C. Stowell, "End of Tour Report, July 1979 – June 1982, 819th Civil Engineering Squadron/ Heavy Repair RED HORSE, 1982, AHO, 64-5; Capt. Steven H. Wiebke, "RED HORSE in the Sudan," *ESQ*, Vol 23, No 1, Spring 1982, 38.

553 Capt. Steven H. Wiebke, "RED HORSE in the Sudan," *ESQ*, Vol 23, No 1, Spring 1982, 38-39.

554 Ibid.

555 Maj. George E. Ehnert, Capt. Ronald V. Descheneaux, and Capt. Terrence E. Kolet, "Proud Phantom, TAC Tackles the Sahara," *ESQ*, Vol 22, No 2, Summer 1981, 4-5.

556 Ibid., 5.

557 Ibid.

558 Ibid.

559 Ibid., 5-6.

560 Ibid., 7-8.
561 Capt. Edward L. Miller, "Pulling Together," *ESQ*, Vol 22, No 3, Fall 1981, 25-28.
562 Ibid.
563 Ibid., 28.
564 "Weekly Activity Report of Team Spirit," 1983, 1984, 1988, AHO; "Team Spirit," GlobalSecurity.org, accessed April 10, 2009, www.globalsecurity.org/military/ops/team-spirit.htm.
565 Capt. Neil H. Fravel, "On the Move," *ESQ*, Vol 22, No 2, Summer 1981, 23; Air Staff History, "History of Directorate of Engineering and Services: 1 January through 30 June 1976." AHO.
566 Capt. Emmitt G. Smith, "Truk'N On…," *ESQ*, Vol 23, No 3, Fall 1982, 44-46.
567 Capt. Neil H. Fravel, "On the Move," *ESQ*, Vol 22, No 2, Summer 1981, 23; Capt. Fred Eng, "Traveling Worldwide," *ESQ*, Vol 25, No 2, Summer 1984, 14-15.
568 Dr. Ronald B. Hartzer, "Engineers and Natural Disaster Recovery," *The CE*, Vol 3, No 3, Winter 1995, 27.
569 "Earthquake in Italy," *TME*, Vol 68, No 445, September-October 1976, 402; Dr. Ronald B. Hartzer, "Engineers and Natural Disaster Recovery," *The CE*, Vol 3, No 3, Winter 1995, 17.
570 Capt. Ronald Andreas, Jr., "The Blizzard of '79," *ESQ*, Vol 22, No 1, February 1981, 30-32.
571 SSgt Run Mucha, "CE responds to old Frederic," *Keesler News*, 21 Sep 1979; History of HQ Air Force Engineering and Services Center, 1 Jan – 31 Dec 1979, 77, AHO.
572 Capt. Jeffrey L. Tyley and Lt. Kurt D. Reynertson, "A Pain in the Ash," *ESQ*, Vol 22, No 1, February 1981, 16-19.
573 Air Staff History, "History of the Directorate of Engineering and Services, Volume I, 1 January 1980 through 30 June 1980, 48, AHO.
574 Capt. Neil H. Fravel, "On the Move," *ESQ*, Vol 22, No 2, Summer 1981, 23
575 Sgt. Lea Blake, "Base Civil Engineers…the 'active' effort," *ESQ*, Vol 24, No 1, Spring 1983, 24-25.
576 Ibid.; E-mail, Col. Marvin Fisher, USAF (Ret) to Dr Ronald B. Hartzer, "History Review," 24 Nov 13, AHO.
577 Dr. Ronald B. Hartzer, "Engineers and Natural Disaster Recovery," *The CE*, Vol 3, No 8, 1995, Winter, 17.
578 Maj. Alexander M. Earle, Jr., "823d RED HORSE Responds from Hurlburt Field," *Air Force Engineering & Services Center Update*, Vol 2, No 1, 1 February 1990, 8-9.
579 "AF Units Deploy for Hugo Cleanup Effort," *Air Force Engineering & Services Center Update*, Vol 1, No 1, March 1990, n.p.
580 "Hurricane Hugo Restoration," *Air Force Engineering & Services Center Update*, Vol 2, No 5, June 1990, 22; Lt. Col. Richard C. Woodworth, "USAF Contributes to Hurricane Hugo Restoration," *Air Force Engineering & Services Center Update*, Vol 2, No 7, July 1990, 12.
581 U.S. Army Environmental Center, Thematic Study and Guidelines: Identification and Evaluation of U.S. Army Cold War Era Military-Industrial Historic Properties, 1997, 61; Robert P. Grathwol and Donita M. Moorhus, *American Forces in Berlin '45 – '94: Cold War Outpost*, DoD, Legacy Resource Management Program, Cold War Project, Washington, D.C. 1994, 160-176.
582 U.S. Army Environmental Center, Thematic Study and Guidelines: Identification and Evaluation of U.S. Army Cold War Era Military-Industrial Historic Properties, 1997, 61; Robert P. Grathwol and Donita M. Moorhus, *American Forces in Berlin '45 – '94: Cold War Outpost*, DoD, Legacy Resource Management Program, Cold War Project, Washington, D.C. 1994, 160-176.
583 Air Staff History, Logistics and Engineering, 1987, 7.
584 Ibid., 8.
585 Air Staff History, Logistics and Engineering, 1989, 1,7-10; "Maj. Gen. Ahearn Addresses AFESC Headquarters Team," *Air Force Engineering & Services Update*, October-December 1989, 34-35.
586 Maj. Gen. Joseph A. Ahearn (USAF, Retired), "Oral History Interview," interview by Dr. Douglas H. Merkle and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, March 2008, 80.
587 Ibid., 96, 106.
588 Ibid.

Chapter 5 Endnotes

1 Donald B. Rice, "Global Reach Global Power: The Evolving Air Force Contribution to National Security," Air Force White Paper prepared by the Department of the Air Force, December 1992, 2.

2 Walter J. Boyne, Beyond the Wild Blue: A History of the United States Air Force 1947-1997, St. Martin's Press, New York, 283-284; Donald B. Rice, "Global Reach Global Power: The Evolving Air Force Contribution to National Security," Air Force White Paper prepared by the Department of the Air Force, December 1992, 1.

3 Frederick J. Shaw, "History's Footprints: USAF Continental Bases," Air Force Historical Research Agency, Maxwell AFB, Alabama, 2004, n.p.

4 Donald B. Rice, "Global Reach Global Power: The Evolving Air Force Contribution to National Security," Air Force White Paper prepared by the Department of the Air Force, December 1992, 2-3.

5 Ibid., 3.

6 Ibid., 3, 14-15.

7 Gen. James E. McCarthy, "CEs Building Quality," TME [hereafter cited as TME] Vol 86, No 563, May 1994, 49.

8 "Air Force Restructure," Air Force White Paper, September 1991, Files of AFCEC History Office, Tyndall AFB, Florida [hereafter cited as AHO]; "Force Restructuring, Secretary Rice Remarks to Air Force Association," HQ Air Force News Center, 20 September 1991, AHO.

9 Walter J. Boyne, Beyond the Wild Blue: A History of the United States Air Force 1947-1997, St. Martin's Press, New York, 315-316, 334-337, 418-419.

10 "Building the Team: An Interview with Maj. Gen. Eugene A. Lupia, the Air Force Civil Engineer," The CE, Vol 3, No 3, Winter 1995, 6.

11 Gen. James E. McCarthy, "Civil Engineering: Foundation of Air Force Readiness," TME, Vol 87, No 571, June-July 1995, 38-40.

12 Air Force Doctrine Document 2-3, "Military Operations Other Than War," 3 July 2000, 12.

13 "An Extended Family," The CE, Vol 4, No 4, Winter 1997, 5.

14 "Global Engagement: A Vision for the 21st Century Air Force," 1996, accessed April 2011, www.au.af.mil/au/awc/awcgate/global/nuvis.htm.

15 Maj. Gregory A. Cummings, "Civil Engineer Blue Suit Wartime Requirements Review," The CE, Vol 5, No 3, Fall 1997, 7.

16 The first three recipients were: Gen. Charles A. Gabriel (1986), Hon. Casper W. Weinberger, (1988), and Gen.Larry D. Welch (1990).

17 H. Perry Sullivan, "The Maj. Gen. Ahearn Legacy: Change with a Vision," CE Update, Vol 4, No 1, March 1992, 2-3; Maj. Gen. Joseph A. Ahearn (USAF, Retired), "Oral History Interview," interview by Dr. Douglas H. Merkle and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, March 2008, xii-xiii; Lois E. Walker, "A Tradition of Excellence," The CE, Vol 7, No 3, Fall 1999, 34.

18 Gary S. Flora, SES, "Oral History Interview," interview by Lois Walker and Dr. Douglas H. Merkle, HQ AFCESA, Tyndall AFB, Florida, September 2005, 43-44.

19 Ibid.; iv-v; H. Perry Sullivan, Jr., "Gary S. Flora Retires," The U.S. Air Force Civil Engineer, [hereafter cited as USAFCE] Vol 2, No 2, March 1994, 12-16.

20 Maj. Gen. James E. McCarthy (USAF, Retired), "Oral History Interview," interview by Dr. Douglas H. Merkle and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, June 2005, 91.

21 Ibid., v-vii.

22 Ibid.,vii; Dr. Ronald B. Hartzer, "Readiness is Job One," The CE, Vol 3, No 2, Summer 1995, 5-6, 42-43, 50-51.

23 Maj. Gen. Eugene A. Lupia (USAF, Retired), "Oral History Interview," interview by Dr. Douglas H. Merkle and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, Draft 2002; "Building the Team: An Interview with Maj. Gen. Eugene A. Lupia, the Air Force Civil Engineer," The CE, Vol 3, No 3, Winter 1995, 5.

24 Kenneth Miller, Email to Ron Hartzer, 23 May 2011, AHO; Kenneth Miller, "Communicate at All Levels," The CE, Vol 5, No 1, Spring 1997, 5.

25 "From the Top: Feedback from the Field," The CE, Vol 4, No 1, Spring 1996, 2.

26 Lt. j.g., USN Shay Meskill, "Navy/Air Force Exchange Program: The 'Bee and The Horse," AFCE, Vol 16, No 1, 2008, 17.

27 Dr. Ronald B. Hartzer, "Building a Team," The CE, Vol 3, No 3, Winter 1995, 4-9; "Maintaining the Readiness Core," The CE, Vol 7, No 2, Summer 1999, 4-9.

28 "Relevant, Right-sized, and Ready: An Interview with the Air Force Civil Engineer, Brig. Gen. Earnest O. Robbins II," The CE, Vol 7, No 3, Fall 1999, 4-9.

29 Walter J. Boyne, Beyond the Wild Blue: A History of the United States Air Force 1947-1997, St. Martin's Press, New York, 313-315.

30 Defense Management Report Decision No. 967, December 1990, 1.

31 Ibid., 1, 6-10, 14.

32 Donald B. Rice, Secretary of the Air Force, Memorandum for the Department of Defense Controller, Subject: Defense Management Report Decision (DMRD) 967, Base Engineering Services,, 1990.

33 Defense Management Report Decision No. 967, 1990, 11.

34 Donald B. Rice, Secretary of the Air Force, Memorandum for the Department of Defense Controller, Subject: Defense Management Report Decision (DMRD) 967, Base Engineering Services, 1990.
35 Ibid.
36 Defense Management Report Decision No. 967, 1990, 6.
37 Donald B. Rice, "Memorandum for the Department of Defense Controller, Subject: Defense Management Report Decision (DMRD) 967," Base Engineering Services, 1990.
38 Lt. Col. Emmitt G. Smith, "Air Force Engineer Squadrons: Shifting Sands or Solid Foundation," research report submitted to Air War College, Air University, Maxwell AFB, Alabama, 1996, 18-19.
39 Ibid, 18-20; Maj. Valerie L. Hasberry, USAF, "Engineering the Future: Organizing United States Air Force Civil Engineers for Joint Operations and the Projection of Airpower," Research paper submitted to U.S. Marine Corps Command and Staff College, Quantico, Virginia, 2002, 4.
40 Walter J. Boyne, Beyond the Wild Blue: A History of the United States Air Force 1947-1997, St. Martin's Press, New York, 315.
41 Maj. Gen. Joseph A. Ahearn, "Protectors of the Environment," TME, Vol 82, No 525, January-February 1990, 11.
42 Maj. Gen. Joseph A. Ahearn (USAF, Retired), "Oral History Interview," interview by Dr. Douglas H. Merkle and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, March 2008, xii; "General Ahearn Briefs New Civil Engineering, Services Order," Engineering and Services Update, Vol 3, No 2, February-March 1991, 1.
43 Maj. Gen. Joseph A. Ahearn (USAF, Retired), "Oral History Interview," interview by Dr. Douglas H. Merkle and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, March 2008, 86-87.
44 Maj. Gen. James E. McCarthy (USAF, Retired), "Oral History Interview," interview by Dr. Douglas H. Merkle and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, June 2005, vi, vii, 69.
45 Ibid., 72.
46 Maj. Gen. Joseph A. Ahearn (USAF, Retired), "Oral History Interview," interview by Dr. Douglas H. Merkle and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, March 2008, 85.
47 Gary S. Flora, SES, "Oral History Interview," interview by Lois Walker and Dr. Douglas H. Merkle, HQ AFCESA, Tyndall AFB, Florida, September 2005, 39-40.
48 Col. Marshall W. Nay, Jr., "Oral History Interview," interview by Dr. Ronald B. Hartzer, HQ AFCESA, Tyndall AFB, Florida, May 2008, 28.
49 Reorganization Meeting, 13 March 1991, HQ AFESC Directors Main Conference Room, AHO.
50 Col. Marshall W. Nay, Jr., "Oral History Interview," interview by Dr. Ronald B. Hartzer, HQ AFCESA, Tyndall AFB, Florida, May 2008, 27-28.
51 Reorganization Meeting, 13 March 1991, HQ AFESC Directors Main Conference Room, AHO.
52 Col. Marshall W. Nay, Jr., "Oral History Interview," interview by Dr. Ronald B. Hartzer, HQ AFCESA, Tyndall AFB, Florida, May 2008, 27-28.
53 Gary S. Flora, SES, "Oral History Interview," interview by Lois Walker and Dr. Douglas H. Merkle, HQ AFCESA, Tyndall AFB, Florida, September 2005, 39-40.
54 "Civil Engineer Reorganization Briefing," May-June 1991, AHO; Maj. Wes Somers, "Civil Engineering Readiness into the 1990s," CE Update, Vol 4, No 1, August 1992, 10.
55 "Civil Engineer Reorganization Briefing," May-June 1991, AHO; "Staff Summary Sheet, Subject: AF/CE Reorganization Approval," 26 June 1991, AHO; Maj. Gen. James E. McCarthy (USAF, Retired), "Oral History Interview," interview by Dr. Douglas H. Merkle and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, June 2005, 59.
56 "Civil Engineer Reorganization Briefing," May-June 1991, AHO.
57 Maj. Wes Somers, "Civil Engineering Readiness into the 1990s," CE Update, Vol 4, No 1, August 1992, 10; "Air Force Restructure," Air Force White Paper, September 1991, AHO.
58 Col. David S. O'Brien, "The Year of Operations and Maintenance: Getting the Job Done at the Base Level," CE Update, Vol 4, No 1, August 1992, 4.
59 Col. Marshall W. Nay, Jr., "Winds of Change: What's in a Name?," CE Update, Vol 3, No 4, December 1991, 6.
60 "Civil Engineer Reorganization Briefing," May-June 1991, AHO; "Staff Summary Sheet, Subject: AF/CE Reorganization Approval," 26 June 1991, AHO.
61 Col. Marshall W. Nay, Jr., "Oral History Interview," interview by Dr. Ronald B. Hartzer, HQ AFCESA, Tyndall AFB, Florida, May 2008, 28-29.
62 "Civil Engineer Reorganization Briefing," May-June 1991, AHO; "Staff Summary Sheet, Subject: AF/CE Reorganization Approval," 26 June 1991, AHO; Maj. Gen. James E. McCarthy (USAF, Retired), "Oral History Interview," interview by Dr. Douglas H. Merkle and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, June 2005, 59.
63 Col. Marshall W. Nay, Jr., "Winds of Change: What's in a Name?," CE Update, Vol 3, No 4, December 1991, 6.
64 "Air Force Real Property Agency," U.S. Air Force Fact Sheet, accessed March 2011, www.af.mil/information/factsheets.
65 "EOD, DP, ABO Now Part of AFCE Organization," CE Update, Vol 3, No 4, December 1991, 15.
66 E-mail, CMSgt (Ret) John J. Glover to Dr. Ronald B. Hartzer, "EOD History," 5 Dec 2013, AHO.

67 Maj. Gen. Joseph A. Ahearn (USAF, Retired), "Oral History Interview," interview by Dr. Douglas H. Merkle and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, March 2008, 86, xii.

68 CMSgt. John J. Glover, "Explosive Ordnance Disposal Begins New Year with AFCESA," USAFCE, Vol 1, No 1, February 1993, 13.

69 Maj. Gen. Joseph A. Ahearn (USAF, Retired), "Oral History Interview," interview by Dr. Douglas H. Merkle and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, March 2008, 85-86.

70 Department of the Air Force, Memorandum Subject: USAF Field Operating Agencies, 17 September 1991; "Air Force Restructure," Air Force White Paper, September 1991, AHO; Col. Marshall W. Nay, Jr., "Winds of Change: What's in a Name?," CE Update, Vol 3, No 4, December 1991, 4.

71 TSgt. Sarah L. Hood, "A New Vision for the Air Force," CE Update, Vol 3, No 4, December 1991, 1; Donald B. Rice, "The Air Force Vision," CE Update, Vol 3, No 4, December 1991, 2.

72 Maj. Gen. Joseph A. Ahearn, "AFCE Outlines A Civil Engineering Vision," CE Update, Vol 3, No 4, December 1991, 1.

73 Maj. Gen. James E. McCarthy, "CEs Building Quality," TME, Vol 86, No 563, May 1994, 50.

74 "Air Force Restructure," Air Force White Paper, September 1991, AHO.

75 Lt. Col. Emmitt G. Smith, "Air Force Engineer Squadrons: Shifting Sands or Solid Foundation," research report submitted to Air War College, Air University, Maxwell AFB, Alabama, 1996, 22.

76 Ibid., 23.

77 Ibid., 23-25.

78 H. Perry Sullivan, "Storm at the Pentagon: AF/CEO Faces Daily Challenges," CE Update, Vol 4, No 1, August 1992, 4-5.

79 "Staff Summary Sheet: Results of the Objective Civil Engineering Squadron Study," 21 May 1992, AHO.

80 Maj. Gen. James E. McCarthy (USAF, Retired), "Oral History Interview," interview by Dr. Douglas H. Merkle and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, June 2005, 72.

81 Lt. Col. Emmitt G. Smith, "Air Force Engineer Squadrons: Shifting Sands or Solid Foundation," research report submitted to Air War College, Air University, Maxwell AFB, Alabama, 1996, 26.

82 H. Perry Sullivan, "Objective Wing Approved," CE Update, Vol 4, No 1, August 1992, 1.

83 Col. David S. O'Brien, "The Year of Operations and Maintenance: Getting the Job Done at the Base Level," CE Update, Vol 4, No 1, August 1992, 3; Maj. Wes Somers, "Civil Engineering Readiness into the 1990s," CE Update, Vol 4, No 1, August 1992, 10.

84 H. Perry Sullivan, Jr., "AFMC Civil Engineer Talks Changes, Manpower Cuts," The CE, Vol 2, No 8, Winter 1995, 4-5, 7, 22-23.

85 Ibid.; Sue Alexander, "Looking Ahead: An Interview with Brig. Gen. Todd I Stewart," The CE, Vol 4, No 2, Summer 1996, 4-7.

86 H. Perry Sullivan, Jr., "Brig. Gen. Michael A. (Mick) McAuliffe (USAF, Ret.): Warrior, Manager, Planner, Believer in Empowerment," USAFCE, Vol 2, No 1, February 1994, 12-16; History, Air Combat Command, Jan-Dec 1992, 320; Jan-Dec 1994, 294-97..

87 Robert Fox, "Air Mobility Command—Global Reach for America, Air Force Civil Engineering Support Agency, Update, Vol 4, No 4, Nov 1992, 20; Maj. Gen. Eugene A. Lupia (USAF, Retired), "Oral History Interview," interview by Dr. Douglas H. Merkle and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, Draft 2002, 72.

88 H. Perry Sullivan, Jr., "RD&A to AFMC," USAFCE, Vol 1, No 1, February 1993, 4-5.

89 H. Perry Sullivan, "New AFI Covers Air Force Civil Engineering and Environmental Quality RD&A Requirements," USAFCE, Vol 2, No 1, February 1994, 18-19.

90 Maj. Gen. James E. McCarthy (USAF, Retired), "Oral History Interview," interview by Dr. Douglas H. Merkle and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, June 2005, 59-60.

91 H. Perry Sullivan, "New AFI Covers Air Force Civil Engineering and Environmental Quality RD&A Requirements," USAFCE, Vol 2, No 1, February 1994, 18-19.

92 Gary S. Flora, SES, "Oral History Interview," interview by Lois Walker and Dr. Douglas H. Merkle, HQ AFCESA, Tyndall AFB, Florida, September 2005, 34-35; "Key Changes Announced by AFCE," USAFCE, Vol 2, No 2, March 1994, 21.

93 H. Perry Sullivan, "Gary S. Flora Retires," USAFCE, Vol 2, No 2, March 1994, 14.

94 Maj. Gen. James E. McCarthy, "CEs Building Quality," TME, Vol 86, No 563, May 1994, 50.

95 "Plans and Programs Update," CE Update, Vol 4, No 2, November 1992, 26.

96 Lt. Col. Emmitt G. Smith, "Air Force Engineer Squadrons: Shifting Sands or Solid Foundation," research report submitted to Air War College, Air University, Maxwell AFB, Alabama, 1996, 27-29.

97 Dr. Ronald B. Hartzer, "Readiness is Job One," The CE, Vol 3, No 2, Summer 1995, 5-6.

98 Walter J. Boyne, Beyond the Wild Blue: A History of the United States Air Force 1947-1997, St. Martin's Press, New York, 314.

99 "Air Force Civil Engineering Manpower Statistics," AHO.

100 Message, HQ USAF/CE to ALMAJCOM/CE, "Name Change for Civil Engineer Function," 041900Z Feb 94, Files of the AFCESA History Office, Tyndall AFB, Florida; Dr. Ronald B. Hartzer, "What's In a Name?," USAFCE, Vol 2, No 2, March 1994, 1.

101 TSgt. John Meekins, "New Civil Engineering Occupational Badge Expected in 1 Year," USAFCE, Vol 1, No 7, September-October 1993, cover, 2.

102 "Civil Engineers Adopt Career-Field Badge," The CE, Vol 2, No 8, Winter 1995, 10; "Badge Elements Link Engineering Profession Principles," The CE, Vol 2, No 8, Winter 1995, 11.

103 Maj. Gen. Eugene A. Lupia (USAF, Retired), "Oral History Interview," interview by Dr. Douglas H. Merkle and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, Draft 2002, 95-96.

104 Maj. Gen. Eugene A. Lupia, "Forging Tomorrow's Installations," TME, Vol 88, No 578, June-July 1996, 49.

105 Maj. Drew Jeter, Maj. Drew Wright, and Capt. Jeffery Vinger, "The Air Force Civil Engineer Outsourcing and Privatization Program," The CE, Vol 4, No 4, Winter 1997, 12-13.

106 Col. John W. Mogge, "Civil Engineers and the Enhanced Air Force Corporate Structure," The CE, Vol 3, No 3, Winter 1995, 12-14.

107 Col. Scott Smith, "Air Staff Reorganization," The CE, Vol 4, No 4, Winter 1997, 14.

108 Maj. Gen. Eugene A. Lupia, "Forging Tomorrow's Installations," TME, Vol 88, No 578, June-July 1996, 49.

109 Maj. Gregory A. Cummings, "Civil Engineer Blue Suit Wartime Requirements Review," The CE, Vol 5, No 3, Fall 1997, 7, 21; Col. H. Dean Bartel, "End of Tour Report," interview by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, June 1999, 3.

110 Joseph H. Smith, "Retirement Interview," interview by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, November 2004, 33-34.

111 "Readiness Update," Engineering & Services Update, Vol 3, No 4, July-August 1991, 25.

112 Maj. Wes Somers, "Civil Engineer Readiness Into the 1990s," CE Update, Vol 4, No 1, August 1992, 10-11.

113 The construction at Al Kharj AB in Saudi Arabia between November 1990 and January 1991 came to typify the model bare base beddown. Joseph H. Smith, "Retirement Interview," interview by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, November 2004, 34.

114 Ibid., 44.

115 Ibid., 44-45.

116 Ibid., 45, 65.

117 Maj. Gregory A. Cummings, "Manpower Briefing," May 1998, AHO.

118 Maj. Gregory A. Cummings, "Civil Engineer Blue Suit Wartime Requirements Review," The CE, Vol 5, No 3, Fall 1997, 7, 21.

119 Maj. Gregory A. Cummings, "Manpower Briefing," May 1998, AHO; Col. H. Dean Bartel, "End of Tour Report," interview by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, June 1999, 4-5.

120 Maj. Gen. Eugene A. Lupia, (USAF, Retired), "Oral History Interview," interview by Dr. Douglas H. Merkle and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, 2002, Draft, 106.

121 William S. Cohen, "Chapter 8: Total Force Integration," in Annual Report to the President and the Congress, 1998, accessed March 2011, www.defenselink.mil/execsec/adr1999/chap8.html.

122 "Partnership That's Right for the Air Force," The CE, Vol 7, No 1, Spring 1999, 4-6.

123 Ibid.

124 Col. Greg Cunningham and Lt. Col. Jim West, "The Austere 'S-Teams'," The CE, Vol 7, No 2, Summer, 1999, 14-16.

125 William S. Cohen, "Chapter 8: Total Force Integration," in Annual Report to the President and the Congress, 1998, accessed March 2011, http://www.defenselink.mil/execsec/adr1999/chap8.html.

126 "Future Total Force," The CE, Vol 7, No 4, Winter 1999-2000, 4-6.

127 "Partnership That's Right for the Air Force," The CE, Vol 7, No 1, Spring 1999, 4-6.

128 "Future Total Force," The CE, Vol 7, No 4, Winter 1999-2000, 4-6.

129 Sue Alexander, "Air Force Stand Up New RED HORSE Unit," The CE, Vol 5, No 3, Fall 1997, 20.

130 "819th RED HORSE Squadron Chronology," AHO.

131 Malstom Air Force Base, "819th RED HORSE Squadron Fact Sheet," accessed June 2011, www.malmstrom.af.mil/library/factsheets/factsheet.asp?id=4683.

132 "Lineage and Honors History of the 819th RED HORSE Squadron (ACC)," AHO.

133 Dr. Ronald B. Hartzer, "Paving the Way: The Original 819th RED HORSE Squadron's First Year," The CE, Vol 5, No 3, Fall 1997, 19.

134 Malstrom Air Force Base, "819th RED HORSE Squadron Fact Sheet," accessed June 2011, www.malmstrom.af.mil/library/factsheets/factsheet.asp?id=4683.

135 "Doctrine Chronology," AHO.

136 Ibid.; "E&S Winner: Maj. Alfred Barrett Hicks, Jr.," Engineering & Services Update, Vol 2, No 1, February 1990, 18.

137 Air Force Manual 3-2 Civil Engineer Combat Support Doctrine, 1991, Foreword.

138 Ronald B. Hartzer, "Validating Air Force Civil Engineering Combat Support Doctrine in the Gulf War," Air Power Journal, Summer 1994, 62-71; Maj. Gen. Joseph A. Ahearn (USAF, Retired), "Oral History Interview," interview by Dr. Douglas H. Merkle and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, March 2008, 80-81.

139 Ibid., Chapter 2.
140 Dr. Ronald B. Hartzer, "Civil Engineers Implement Revised Doctrine," The CE, Vol 3, No 2, Summer 1995, 12-13, 47; Air Force Doctrine Document 42: Civil Engineer, 28 December 1994.
141 "Doctrine Chronology," AHO.
142 Maj. Alfred Barrett Hicks, Jr., "A Gathering of Our Founders," Air Force Engineering & Services Center Update, July-August, 1989, 10-11; Maj. Gen. Joseph A. Ahearn (USAF, Retired), "Oral History Interview," interview by Dr. Douglas H. Merkle and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, March 2008, 111-112.
143 Maj. Gen. Joseph A. Ahearn (USAF, Retired), "Oral History Interview," interview by Dr. Douglas H. Merkle and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, March 2008, 96, 106.111.
144 Maj. Alfred Barrett Hicks, Jr., "A Gathering of Our Founders," Air Force Engineering & Services Center Update, July-August, 1989, 10-11.
145 Capt. Francis J. Mondo, "Analysis of Air Force Civil Engineering Strategic Planning," Thesis, AFIT, Air University, Maxwell AFB, Alabama, 2003, 30.
146 Maj. Gen. Eugene A. Lupia, "Forging Tomorrow's Installations," TME, Vol 88, No 578, June-July 1996, 49.
147 Department of the Air Force, Civil Engineer Strategic Plan, Volume 1, HQ USAF/ILE, June 1999; Department of the Air Force, Civil Engineer Strategic Plan, Volume 2, HQ USAF/ILE, September 2000.
148 Capt. Francis J. Mondo, "Analysis of Air Force Civil Engineering Strategic Planning," Thesis, AFIT, Air University, Maxwell AFB, Alabama, 2003, 31-33; Maj. Valerie L. Hasberry, "Engineering the Future: Organizing United States Air Force Civil Engineers for Joint Operations and the Projection of Air Power," Thesis, U.S. Marine Corps Command and Staff College, Quantico, Virginia, 2002, 15-16.
149 Maj. Gen. Earnest O. Robbins II, "Linking Planning to Programming," The CE, Vol 8, No 4, Winter 2000, 2.
150 Capt. Francis J. Mondo, "Analysis of Air Force Civil Engineering Strategic Planning," Thesis, AFIT, Air University, Maxwell AFB, Alabama, 2003, 34-36.
151 Maj. Valerie L. Hasberry, "Engineering the Future: Organizing United States Air Force Civil Engineers for Joint Operations and the Projection of Air Power," Thesis, U.S. Marine Corps Command and Staff College, Quantico, Virginia, 2002, 24-28.
152 Quoted from the Civil Engineer Strategic Plan, Vol 2, 2000, 10-12 in Capt. Francis J. Mondo, "Analysis of Air Force Civil Engineering Strategic Planning," Thesis, Graduate School of Engineering and Management, AFIT, Air University, Maxwell AFB, Alabama, 2003, 34.
153 Ibid., 29-30.
154 "Maintaining the Readiness Core," The CE, Vol 7, No 2, Summer 1999, 9; Maj. Gen. Earnest O. Robbins II, "Linking Planning to Programming," The CE, Vol 8, No 4, Winter 2000, 2.
155 Maj. Valerie L. Hasberry, "Engineering the Future: Organizing United States Air Force Civil Engineers for Joint Operations and the Projection of Air Power," Thesis, U.S. Marine Corps Command and Staff College, Quantico, Virginia, 2002, 29-30.
156 Maj. Gen. Earnest O. Robbins II, "Linking Planning to Programming," The CE, Vol 8, No 4, Winter 2000-2001, 2.
157 Maj. Gen. Joseph A. Ahearn, "Protectors of the Environment," TME, Vol 82, No 525, January-February 1990, 11; "Civil Engineer Reorganization Briefing," May-June 1991, AHO.
158 Col. Roy G. Kennington, "Glue, Paper and Flies," Engineering & Services Update, Vol 2, No 3, May 1990, 4.
159 Col. Marshall W. Nay, Jr., "Oral History Interview," interview by Dr. Ronald B. Hartzer, HQ AFCESA, Tyndall AFB, Florida, May 2008, 24.
160 "ATC E&S Conference: Center's Support to Desert Shield/Storm Outlined," Engineering & Services Update, Vol 3, No 3, May-June 1991, 1.
161 Col. Marshall W. Nay, Jr., "When the Chips are Down E&S is There," Engineering & Services Update, Vol 2, No 8, September 1990, 4; Maj. Gen. Joseph A. Ahearn (USAF, Retired), "Oral History Interview," interview by Dr. Douglas H. Merkle and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, March 2008, 83-84.
162 Department of the Air Force, Memorandum Subject: "USAF Field Operating Agencies and Direct Reporting Units," 4 February 1991, Files of Air Force Historical Research Agency, Maxwell AFB, Florida.
163 "Air Force Restructure," Air Force White Paper, September 1991, AHO.
164 "Civil Engineer Reorganization Briefing," May-June 1991, AHO.
165 Col. Marshall W. Nay, Jr., "Winds of Change: What's in a Name?," CE Update, Vol 3, No 4, December 1991, 6.
166 Department of the Air Force, Memorandum Subject" "USAF Field Operating Agencies," 17 September 1991, Files of Air Force Historical Research Agency, Maxwell AFB, Florida.
167 Dr. Ronald B. Hartzer, "What's In a Name?," USAFCE, Vol 2, No 2, March 1994, 1.
168 Col. Marshall W. Nay, Jr., "Winds of Change: What's in a Name?," CE Update, Vol 3, No 4, December 1991, 5.
169 "Systems Engineering: Designed for Customer Service," CE Update, Vol 3, No 4, December 1991, 8.
170 Col. Marshall W. Nay, Jr., "Winds of Change: What's in a Name?," CE Update, Vol 3, No 4, Dec 1991,

6-7.

171 "CE Notes: Civic Action Teams," CE Update, Vol 3, No 4, December 1991, 13.

172 Maj. Gen. James E. McCarthy (USAF, Retired), "Oral History Interview," interview by Dr. Douglas H. Merkle and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, June 2005, 58-59.

173 CMSgt. John A. Glover, "Anniversary: Explosive Ordnance Disposal Begins New Year with AFCESA," USAFCE, Vol 1, No 1, February 1993, 13.

174 "History of the Explosive Ordnance Disposal (EOD) in the Air Force Logistics Command – A Chronology," AHO.

175 CMSgt. John A. Glover, "Anniversary: Explosive Ordnance Disposal Begins New Year with AFCESA," USAFCE, Vol 1, No 1, February 1993, 13.

176 MSgt. Jeffrey Schley, "Clearing the Jungles of Panama," The CE, Vol 7, No3, Fall 1999, 10.

177 Ibid., 11.

178 FY2000 EOD Annual Report, n.d., n.p., AHO.

179 Ibid.

180 APFD 32-30, Explosive Ordnance Disposal, 3 March 1993, n.p., AHO.

181 FY2000 EOD Annual Report, n.d., n.p., AHO; Joint POW/MIA Accounting Command, "JPAC Mission Overview," accessed March 2011, www.jpac.pacom.mil/index.

182 Lois E. Walker, "A Tradition of Excellence," The CE, Vol 7, No 4, Winter 1999-2000, 30.

183 Larry Hull, "Air Force Emergency Management History," 3-4, AHO.

184 Ibid., 6, AHO.

185 Ibid., 8-9, AHO.

186 TSgt. Eddie C. Riley, "Kelly CEMIRT Site Shuts Down After Achieving 'Hero' Status," The CE, Vol 4, No 1, Spring 1996, 22.

187 "CEMIRT History Notes," AHO.

188 Sue Alexander, "Combined CEMIRT Team Saves Ridley's Generators," Air Force Civil Engineer Vol 5, No 3, Fall 1997, 21.

189 1997 Annual History Input AFCESA/CEM, Field Support Directorate, AHO.

190 Portia R. McCracken, "Bird Strikes and the Air Force," Wildlife Damage Management, Internet Center for Bird Control Seminars Proceedings, University of Nebraska, 1976, 68.

191 Maj. Ronald L. Merritt, "US Air Force Bird Aircraft Strike Hazard (BASH): Summary Report for 1993," AHO.

192 Air Force Pamphlet 91-212, Bird/Wildlife Aircraft Strike Hazard (BASH) Management Techniques, 1997, 7-15.

193 Maj. Ronald L. Merritt, "US Air Force Bird Aircraft Strike Hazard (BASH): Summary Report for 1993," AHO.

194 "AFCESA Technologies Cited by CERF," CE Update, Vol 3, No 4, December 1991, 12.

195 "Civilian of the Year: Tom Burns Earns Honor," CE Update, Vol 4, No 1, March 1992, 12.

196 "Automated Cost Engineering System (ACES) Meeting," Engineering &Services Update, Vol 2, No 8, November 1990, 18.

197 "CCMAS Update," CE Update, Vol 4, No 1, March 1992, 28.

198 H. Perry Sullivan, Jr., "Patent: CCMAS Now Protected," CE Update, Vol 4, No 2, November 1992, 3.

199 Ed Page, "Deputy Assistant Secretary of the Air Force Validates AFCESA Cost Analysis Programs," USAFCE, Vol 1, No 4, May-June 1993, 10.

200 "Civilian of the Year: Tom Burns Earns Honor," CE Update, Vol 4, No 1, March 1992, 12.

201 "CCMAS Update," CE Update, Vol 4, No 1, March 1992, 28.

202 "Construction Cost Update," CE Update, Vol 4, No 4, November 1992, 25.

203 "Construction Cost Update," USAFCE, Vol 1, No 2, March 1993,16.

204 Ed Page, "Deputy Assistant Secretary of the Air Force Validates AFCESA Cost Analysis Programs," USAFCE, Vol 1, No 4, May-June 1993, 10.

205 "AFCESA Web News," Vol 7, July 2001, AHO.

206 "New AFCESA Commander Pledges Support to Squadrons," USAFCE, Vol 2, No 5, July-August 1994, 23.

207 Col. Paul Hains, "Agency Relook" Briefing, 7 Nov 1994, Files of AFCESA History Office; "New AFCESA Ready for the Future," USAFCE, Vol 2, No 7, November-December 1994, 19.

208 See note above.

209 Dr. Ronald B. Hartzer, "AFCESA Takes New Structure, New Direction," The CE, Vol 2, No 8, Winter 1995, 14, 15, 29.

210 Ibid.

211 Col. Paul W. Hains III, "From the Top: AFCESA—Meeting the Challenge of a Changing World," The CE, Vol 2, No 8, Winter 1995, 2.

212 "Kloeber Leaves AFCESA," The CE, Vol 4, No 2, Summer 1996, 7; Dennis Firman, "Agency Establishes Board of Advisors," The CE, Vol 3, No 2, Summer 1995, 39.

213 Lois Walker, History of the Air Force Civil Engineer Support Agency (RCS: HAF-HO[A]7101), 1 January – 31 December 1999, n.p., AHO.

214 "AFCESA Earns Air Force Award," The CE, Vol 7, No 1, Spring 1999, 33.

215 History of the Air Force Civil Engineer Support Agency (RCS: HAF-HO[A]7101), 1 January – 31 December 2000, Chronology, 1, AHO.

216 Joseph H. Smith, "Oral History Interview," interview by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, November 2004, vi, 50-54.

217 Sue Alexander, "AFCAP and the New Multiplication," The CE, Vol 5, No 2, Summer 1997, 26, 29.

218 Ibid.

219 Joseph H. Smith, "Oral History Interview," interview by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, November 2004, 51-52, 54.

220 Joseph H. Smith, "Bullet Background Paper: Update of AFCAP Activities," October 2000, Files of AFCESA History Office, AFCESA, Tyndall AFB, Florida.

221 Col. Frank J. Destadio, "Focus On Team Building," The CE, Vol 6, No 1, Spring 1998, 6.

222 Dr. Ronald B. Hartzer, History of the Air Force Civil Engineer Support Agency, 1 January – 31 December 1997, AHO.

223 Ibid.

224 Joseph H. Smith, "Bullet Background Paper: Update of AFCAP Activities," October 2000, AHO.

225 "Keesler AFB Activates AFCAP," The CE, Vol 6, No 3, Fall 1998, 20.

226 Joseph H. Smith, "Oral History Interview," interview by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, November 2004, 51-52, 54.

227 Joseph H. Smith, "Bullet Background Paper: Update of AFCAP Activities," October 2000, AHO.

228 Dr. Ronald B. Hartzer, "History of the Air Force Civil Engineer Support Agency, 1 January – 31 December 1999," Appendix H.

229 Lois E. Walker, "Air Force Engineer Support to Kosovo Operations, JTF Allied Force (Operation Noble Anvil), JTF Shining Hope (Operation Sustain Hope)," History Office, AFCESA, Tyndall AFB, Florida, 1999, 47, 12, 31, 42.

230 "Support the Mission," The CE, Vol 8, No 1, Spring 2000, 5.

231 TSgt. Michael Ward, "AFCAP Implemented to Aid Earthquake Victims," The CE, Vol 7, No 4, Winter 1999-2000, 22; Dr. Ronald B. Hartzer, "History of the Air Force Civil Engineer Support Agency 1 January – 31 December 1999," Appendix H.

232 TSgt. Michael Ward, "AFCAP Used to Help Kosovars Survive Winter," The CE, Vol 8, No 1, Spring 2000, 25; Joseph H. Smith, "Oral History Interview," interview by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, November 2004, 52-53.

233 Joseph H. Smith, "Bullet Background Paper: Update of AFCAP Activities," October 2000, AHO.

234 Dr. Ronald B. Hartzer, "History of the Air Force Civil Engineer Support Agency 1 January – 31 December 2000," Appendix H, n.p., and Chronology, 14,16; "AFCAP Recruits Power Pros," The CE, Vol 8, No 4, Winter 2000-2001, 24-25.

235 Joseph H. Smith, "Bullet Background Paper: Update of AFCAP Activities," October 2000, AHO.

236 "General Ahearn to Retire Feb. 1," CE Update, Vol 3, No 4, December 1991.

237 Col. Marshall W. Nay, Jr., "What's In a Name?," CE Update, Vol 3, No 4, December 1991, 6.

238 H. Perry Sullivan, Jr., "Environment: Leadership Conference Series a Success," Engineering & Services Update, Vol 3, No 1, January 1991, 1-2; Maj. Gen. Joseph A. Ahearn (USAF, Retired), "Oral History Interview," interview by Dr. Douglas H. Merkle and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, March 2008, 54-55.

239 Maj. Gen. Joseph A. Ahearn (USAF, Retired), "Oral History Interview," interview by Dr. Douglas H. Merkle and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, March 2008, 101.

240 Maj. Gen. James E. McCarthy (USAF, Retired), "Oral History Interview," interview by Dr. Douglas H. Merkle and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, June 2005, 62.

241 Ibid.

242 Ibid., 63.

243 Col. Marshall W. Nay, Jr., "Environment: A Complex Challenge," Engineering & Services Update, Vol 3, No 4, July-August 1991, 4.

244 Maj. Gen. James E. McCarthy (USAF, Retired), "Oral History Interview," interview by Dr. Douglas H. Merkle and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, June 2005, 54.

245 Col. Marshall W. Nay, Jr., "Oral History Interview," interview by Dr. Ronald B. Hartzer, HQ AFCESA, Tyndall AFB, Florida, May 2008, 27-28; Gary S. Flora, SES, "Oral History Interview," interview by Lois Walker and Dr. Douglas H. Merkle, HQ AFCESA, Tyndall AFB, Florida, September 2005, 39-40.

246 "Civil Engineer Reorganization Briefing," May-June 1991, AHO; "Staff Summary Sheet, Subject: AF/CE Reorganization Approval," 26 June 1991, AHO.

247 Gil Dominguez, "Past Leaders Shaped Center's Future," CenterViews, Vol 7, No 3, Summer 2001, 7; H. Perry Sullivan, Jr., "J.B. Cole Retires at AFCEE," USAFCE, Vol 1, No 10, December 1993, 14-15.

248 Maj. Gen. James E. McCarthy (USAF, Retired), "Oral History Interview," interview by Dr. Douglas H. Merkle and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, June 2005, 53.

249 Office of The Civil Engineer, Memorandum, Subject: General Notice on Establishment of Air Force Center for Environmental Excellence, July 1991; Department of the Air Force, Memorandum, Subject: HQ,

AFCEE, 23 July 1991; Gil Dominguez, "Past Leaders Shaped Center's Future," CenterViews, Vol 7, No 3, Summer 2001, 7; Gil Dominguez, "Reorganization Continues Legacy," CenterViews, Vol 10, No 1, Spring 2004, 8.

250 "Celebrating a Decade of Excellence," CenterViews, Vol 7, No 3, Summer 2001, 5.

251 "AFCEE is Dedicated at Kelly," CE Update, Vol 3, No 4, December 1991, 15.

252 "Civil Engineer Reorganization Briefing," May-June 1991, AHO.

253 Col. Marshall W. Nay, Jr., "What's In a Name?," CE Update, Vol 3, No 4, December 1991, 6.

254 Maj. Gen. James E. McCarthy (USAF, Retired), "Oral History Interview," interview by Dr. Douglas H. Merkle and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, June 2005, 59-60.

255 H. Perry Sullivan, Jr., "J.B. Cole Retires at AFCEE," USAFCE, Vol 1, No 10, December 1993, 15; H. Perry Sullivan, Jr., "Col. Joe Saenz: Texan with Two Missions," CE Update, Vol 4, No 1, March 1992, 15; Gil Dominguez, "Past Leaders Shaped Center's Future," CenterViews, Vol 7, No 3, Summer 2001, 8-9.

256 H. Perry Sullivan, Jr., "J.B. Cole Retires at AFCEE," USAFCE, Vol 1, No 10, December 1993, 14-15.

257 H. Perry Sullivan, Jr., "Col. Joe Saenz: Texan with Two Missions," CE Update, Vol 4, No 1, March 1992, 15.

258 H. Perry Sullivan, Jr., "J.B. Cole Retires at AFCEE," USAFCE, Vol 1, No 10, December 1993, 14-15.

259 "Coming Back to AFCEE," CenterViews, Vol 7, No 3, Summer 2001, 12; H. Perry Sullivan, Jr., "J.B. Cole Retires at AFCEE," USAFCE, Vol 1, No 10, December 1993, 15.

260 H. Perry Sullivan, Jr., "J.B. Cole Retires at AFCEE," USAFCE, Vol 1, No 10, December 1993, 14-15.

261 Gil Dominguez, "Air Force Environmental Experts Meet," USAFCE, Vol 1, No 2, March 1993, 9.

262 "Small Beginning, Big Success," CenterViews, Vol 7, No 3, Summer 2001, 13; "AFCEE Marks 15th Anniversary," CenterViews, Vol 12, No 2, Summer 2006, 13.

263 "Service is Spelled PRO-ACT," Vol 7, No 3, Summer 2001, 14; "PROACT Provides the Answers to Environmental Questions," CenterViews, Vol 10, No 2, Summer 2004, 26.

264 Gil Dominguez, "Past Leaders Shaped Center's Future," CenterViews, Vol 7, No 3, Summer 2001, 9.

265 Gil Dominguez, "Thirty Years of Design Excellence," CenterViews, Vol 11, No 3, Fall 2004, 4-7.

266 H. Perry Sullivan, Jr., "J.B. Cole Retires at AFCEE," USAFCE, Vol 1, No 10, December 1993, 14-15; "Director Reflects on AFCEE's First Two Years," CenterViews, July-August 1993, 4-5.

267 "Interview with the Commander," CenterViews, March-April-May 1994, 4-5.

268 "Center Contracts Top $1.24 Billion," CenterViews, June-July 1994, 1.

269 Jennifer Schneider, "The Man Behind the AFCEE Shield," Air Force Print News, accessed July 2011, www.afcee.af.mil/news/story_print.

270 AFCEE, "About AFCEE," accessed March 2011, www.afcee.af.mil/about; "Ceremony Marks Start of New AFCEE Building," Centerviews, June-July 1994, 1; "After Four Years, a Place to Call 'Home'," Center-Views, Vol 7, No 3, Summer 2001, 11.

271 Gil Dominguez, "Reorganization Continues Legacy," CenterViews, Vol 10, No 1, Spring 2004, 9-10.

272 "Gary Erickson New Director of AFCEE," The CE, Vol 4, No 2, Summer 1996, 28.

273 "Safeguarding the Future," The CE, Vol 5, No 2, Summer 1997, 4-6.

274 "AFCEE Celebrates a Decade of Service," Air Force Civil Engineer, Vol 9, No 2, Summer 2001, 34.

275 Maj. Gen. James E. McCarthy, "Meeting the Future," TME, Vol 85, No 555, March-April 1993, 35-38.

276 Andrew R. Jackson, Jr., "Civil Engineering Objective Squadron Update," USAFCE, Vol 1, No 5, July 1993, 8.

277 H. Perry Sullivan, Jr. "Objective Wing Approved," CE Update, Vol 4, No 1, August 1992, 1.

278 Col. David S. O'Brien, "The Year of Operations and Maintenance: Getting the Job Done at the Base Level," CE Update, Vol 4, No 1, August 1992, 3.

279 Andrew R. Jackson, Jr., "Civil Engineering Objective Squadron Update," USAFCE, Vol 1, No 5, July 1993, 8.

280 Air Force Pamphlet 32-1005 "Working in the Engineering Flight," 1 October 1999, 6.

281 Col. David S. O'Brien, "The Year of Operations and Maintenance: Getting the Job Done at the Base Level," CE Update, Vol 4, No 1, August 1992, 3-4.

282 Maj. Gen. Joseph A. Ahearn (USAF, Retired), "Oral History Interview," interview by Dr. Douglas H. Merkle and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, March 2008, 99.

283 Col. David S. O'Brien, "The Year of Operations and Maintenance: Getting the Job Done at the Base Level," CE Update, Vol 4, No 1, August 1992, 3-4.

284 Ibid.; SMSgt. Doorbal, "Bullet Background Paper on Military Multi-skilling," 17 October 1997, AHO; Air Force Pamphlet 32-1004, "Working in the Operations Flight," 1 September 1998, 34.

285 Lt. Col. Susanne M. Waylett, AF CE Objective Civil Engineering Squadron-Initiatives, 2 December 1992, Attachment 1 to letter to HQ USAF/CEOO, HQ AFCESA/EN/DX, AFCEE/ES, AHO.

286 Maj. Gen. James E. McCarthy (USAF, Retired), "Oral History Interview," interview by Dr. Douglas H. Merkle and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, June 2005, 74.

287 Ibid.

288 "CE Briefs," USAFCE, Vol 1, No 8, 20.

289 Col. Marshall W. Nay, Jr., "Transition Training," USAFCE, Vol 1, No 1, February 1993, 2.

290 Lt. Col. Susanne M. Waylett, AF CE Objective Civil Engineering Squadron-Initiatives, 2 December

1992, Attachment 1 to letter to HQ USAF/CEOO, HQ AFCESA/EN/DX, AFCEE/ES, AHO.

291 CMSgt. Kenneth Miller, "Multiskilling…Just Do It," The CE, Vol 3, No 3, Winter 1995, 10-11.

292 Zonal Maintenance Guide, Prepared by AFCESA, 1990; Air Force Instruction 32-1031, "Operations Management," 11 March 1994, Section 1.11.

293 Zonal Maintenance Guide, Prepared by AFCESA, 1990.

294 Maj. Gen. James E. McCarthy (USAF, Retired), "Oral History Interview," interview by Dr. Douglas H. Merkle and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, June 2005, 73.

295 Maj. Gen. Eugene A. Lupia, "The Operations Flight," The CE, Vol 5, No 4, Winter 1998, 2.

296 Andrew Jackson, "Update on the Operations Flight," The CE, Vol 6, No 2, Summer 1998, 7.

297 CMsgt. Robert E. Reyff, "Deliveries Announced: P-23 Now Replacing P-2s Worldwide," U.S. Air Force Civil Engineer, Vol 1, No 3, April 1993, 7.

298 Sue Alexander, "Air Force Training Pit Commissioning Program Gains Ground at Fairchild," The CE, Vol 6, No 2, Summer 1998, 18-21.

299 Tech. Sgt. Eddie C. Riley, "McConnell Fire Station is Air Force "Model" Facility," The CE, Vol 4, No 2, Summer 1996, 18-20.

300 Col. H. Dean Bartel, "End of Tour Report," interview by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, June 1999, 1.

301 Ibid., 1-3.

302 Larry Belcher, "Tinker Engineers Air Oklahoma Rescue Efforts," The CE, Vol 3, No 2, Summer 1995, 8-11.

303 "Firefighters Respond to Anthrax Threat," The CE, Vol 6, No 3, Fall 1998, 25.

304 Lois E. Walker, "A Tradition of Excellence," The CE, Vol 7, No 4, Winter 1999-2000, 30.

305 Chief Master Sgt. James E. Podolske, Jr. "Recognizing DoD's Best Firefighters," The CE, Vol 6, No 2, Summer 1996, 22.

306 Larry Hull, "Air Force Emergency Management History," ca. 2007, 3-4, AHO.

307 Ibid., 6, AHO.

308 Department of the Air Force, Air Force Handbook 34-4014, USAF Operations in a Chemical and Biological (CB) Warfare Environment, Planning and Analysis, 1 March 1998, 12-13.

309 Ibid., 9, 12.

310 Larry Hull, "Air Force Emergency Management History," ca. 2007, 9, AHO; "Disaster Preparedness: Operating Location 'M' on Board with AFCESA at Lowry," CE Update, Vol 3, No 4, December 1991, 14.

311 TSgt. Steve Reed, "Disaster Preparedness Sets for Merger," The CE, Vol 3, No 2, Summer 1995, 52.

312 Lois E. Walker, "A Tradition of Excellence," The CE, Vol 7, No 4, Winter 1999-2000, 29-30; Larry Hull, "Air Force Emergency Management History," ca. 2007, 3-4, AHO.

313 United States Air Force, Force Protection, Air Force Doctrine Document 2-4.1, 29 October 1999, 2-4.

314 "Commanders Facility Assessment Program," USAFCE, Vol 1, No 4, May-June 1993, 22; "Commander's Facility Assessment," USAFCE, Vol 1, No 10, December 1993, 10.

315 Maj. Gen. James E. McCarthy, "CEs Building Quality," TME, Vol 86, No 563, May 1994, 51-52; Maj. Gen. James E. McCarthy (USAF, Retired), "Oral History Interview," interview by Dr. Douglas H. Merkle and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, June 2005, 84.

316 H. Perry Sullivan, Jr., "Merging Philosophies: AFMC Civil Engineer Talks Changes, Manpower Cuts," The CE, Vol 2, No 8, Winter 1995, 7.

317 Maj. Gen. James E. McCarthy, "CEs Building Quality," TME, Vol 86, No 563, May 1994, 51-52.

318 Maj. Gen. James E. McCarthy, "Civil Engineering: Foundation of the Air Force," TME, Vol 87, No 571, June-July 1995, 38-40.

319 Perry Sullivan, "Profile in Leadership: Brig. Gen. Eugene A. Lupia, Deputy Chief of Staff, Civil Engineering, HQ Air Mobility Command, Scott AFB, Ill." Air Force Civil Engineering Support Agency Update," Vol 4, No 2, Nov 1992, 22; Maj. Gen. Eugene A. Lupia (USAF, Retired), "Oral History Interview," interview by Dr. Douglas H. Merkle and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, Draft 2002, 64-5; Air Mobility Command, Commander's Guide to Facility Excellence," Jan 1993, i.

320 Maj. Gen. James E. McCarthy, "CEs Building Quality," TME, Vol 86, No 563, May 1994, 51.

321 "Defense Reform Initiative Directive # 36 – Disposal/Demolition of Excess Structures," 5 May 1998, accessed April 2011, www.defense.gov/dodreform/drids.htm.

322 Air Force Defense Reform Initiative Directive (DRID) #36 Demolition Status, ILER WAR 2 May 2003, AHO.

323 CMSgt. Vickie M. Graham, "Interview: Gary Vest," Airman, April 1992, 19.

324 MSgt. Phil Rhodes, "An Eye on 2000," Airman, April 1992, 31.

325 Col. Marshall W. Nay, Jr., Professional Technical Letter – Air Force Civil Engineering Environmental Awareness Program, 2 July 1992, AHO.

326 CMSgt. Vickie M. Graham, "A Little Big Deal," Airman, April 1992, 21.

327 Department of the Interior, "White House Closing the Circle Awards," accessed March 2011, www.doi.gov/greening/awards/whawards.html.

328 AFCEE, "Success Story, Spotlight on McClellan AFB," Pro Act Fact Sheet, October 1998, accessed March 2011, www.afcee.af.mil/.

329 "Bases Win Environmental Awards," The CE, Vol 6, No 2, Summer 1998.

330 AFCEE, "U.S. Air Force Installation Pollution Prevention Program Guide and Sample Pollution Prevention Management Action Plan," HQ AFCEE/EP, July 1996, 5.

331 AFCEE, "Pollution Prevention Opportunity Assessments," May 2005, 1-2, accessed March 2011, www.afcee.af.mil/.

332 Air Force Instruction 32-7080, Pollution Prevention Programs, 12 May 1994, 5.

333 Maj. John Cawthorne, "International Partners in Environmental Security," The CE, Vol 6, No 2, Summer 1998, 14-15.

334 Maj. Gen. Eugene A. Lupia, "Farewell Friend," The CE, Vol 6, No 1, Spring 1998, 8-10.

335 John Bale, "AICUZ Links with Community Action: Joint-Use Land Studies Prevent Encroachment," Engineering & Services Update, Vol 2, No 8, September 1990, 10.

336 Air Force Instruction 32-7065: Cultural Resources Management, 1994, 1.

337 MSgt. Louis A. Arana-Barradas, "Preserving Air Force History," The CE, Vol 3, No 3, Winter 1995, 27.

338 U.S. Department of the Interior, National Register of Historic Places, List of National Register Listed Air Force properties, 1991. From RCGA, Inc. files.

339 MSgt. Louis A. Arana-Barradas, "Preserving Air Force History," The CE, Vol 3, No 3, Winter 1995, 27.

340 Department of Defense, "Defense Department Compliance with the NHPS: Section 202 (a)(6) Evaluation Report," 1994, accessed April 2011, www.achp.gov/defenseexcerpt.html.

341 Office of the Assistant Secretary of Defense, News Release No. 202-99, 27 April 1999, accessed April 2011, www.defense.gov/releases/release.aspx?releaseid=2070.

342 Col. Marshall W. Nay, Jr., "Energy Awareness," CE Update, Vol 4, No 3, September 1992, 6.

343 Freddie L. Beason, "Air Force Approach to Energy Conservation," CE Update, Vol 4, No 3, September 1992, 8-10.

344 "Bullet Background Paper on Air Force Facility Energy Program History," 23 Apr 2007, AHO.

345 Ibid..

346 Ibid.

347 "DMRD 924 Software Design Activity (SDA) Working Group)," Engineering & Services Update, Vol 3, No 4, July-August 1991, 27; Maj. Dennis Anderson, "Moving Automation Toward the 21st Century," The CE, Vol 4, No 2, Summer 1996, 13.

348 Maj. Barry Wentland, "WIMS Marches On," Engineering & Services Update, Vol 3, No 2, February-March 1991, 12.

349 Maj. Barry Wentland, "Software Progress Report: Delivery Rate Increases," Engineering & Services Update, Vol 3, No 1, January 1991, 10.

350 Maj. Barry Wentland, "WIMS Marches On," Engineering & Services Update, Vol 3, No 2, February-March 1991, 12.

351 "BEAMS Elimination Delayed," CE Update, Vol 3, No 4, May-June 1991, 23.

352 "BEAMS Evolution," CE Update, Vol 3, No 3, December 1991, 25.

353 Dr. Ronald B. Hartzer, "AFCESA Takes New Structure, New Direction," The CE, Vol 2, No 8, Winter 1995, 14, 15, 29.

354 Robert D. Wolff and Robert Clearwater, "Automation Strategic Plan," The CE, Vol 4, No 1, Spring 1996, 10.

355 Ibid., 10, 12.

356 Ibid.

357 "An Extended Family," The CE, Vol 4, No 4, Winter 1997, 5.

358 Maj. Dennis Anderson, "Moving Automation Toward the 21st Century," The CE, Vol 4, No 2, Summer, 13.

359 Lois E. Walker, History of the Air Force Civil Engineer Support Agency (RCS: HAF-HO[A]7101, 1 January – 31 December 1998, Chronology, 1999, n.p., AHO.

360 Maj. Dennis Anderson, "Moving Automation Toward the 21st Century," The CE, Vol 4, No 2, Summer, 13.

361 Lois E. Walker, History of the Air Force Civil Engineer Support Agency (RCS: HAF-HO[A]7101), 1 January – 31 December 1999, Chronology, ix, AHO.

362 "CE Briefs," USAFCE, Vol 1, No 8, November 1993, 20.

363 Maj. Drew Jeter, Maj. Drew Wright, and Capt. Jeffery Vinger, "The Air Force Civil Engineer Outsourcing and Privatization Program," The CE, Vol 4, No 4, Winter 1997, 12-13.

364 Lt. Col. Emmitt G. Smith, "Air Force Engineer Squadrons: Shifting Sands or Solid Foundation," research report, Air War College, Air University, Maxwell AFB, Alabama, 1996, 29-30.

365 Maj. Drew Jeter, Maj. Drew Wright, and Capt. Jeffery Vinger, "The Air Force Civil Engineer Outsourcing and Privatization Program," The CE, Vol 4, No 4, Winter 1997, 12-13.

366 Capt. Andrew D. Pope, "The Military Construction (MILCON) Program and Privatization: A Comparative Analysis," Thesis, AFIT, WPAFB, Ohio September 1990, 9.

367 Maj. Drew Jeter, Maj. Drew Wright, and Capt. Jeffery Vinger, "The Air Force Civil Engineer Outsourcing

and Privatization Program," The CE, Vol 4, No 4, Winter 1997, 12-13.

368 Patricia Coyle, "A-76 Help Desk in Full Operation," The CE, Vol 7, No 1, Spring 1999, 27.

369 Maj. Drew Jeter, Maj. Drew Wright, and Capt. Jeffery Vinger, "The Air Force Civil Engineer Outsourcing and Privatization Program," The CE, Vol 4, No 4, Winter 1997, 12-13.

370 Ibid.

371 Patricia Coyle, "A-76 Help Desk in Full Operation," The CE, Vol 7, No 1, Spring 1999, 27.

372 Lt. Col. Alberto Armesto and Capt. Vicki Buschur, "Civil Engineering Outsourcing: What Does It All Mean?," The CE, Vol 5, No 4, Winter 1998, 7, 27.

373 Ibid.

374 Sue Alexander, "Looking Ahead: An Interview with Brig. Gen. Todd I Stewart," The CE, Vol 4, No 2, Summer 1996, 4-7.

375 AFMC Commanders' Conference Briefing, 8-9 April 1997, History of the Air Force Materiel Command 1 October 1996-30 September 1997, Appendix 2, Air Force Historical Research Agency, Maxwell AFB, Alabama.

376 Lt. Col. Kathy Ward, "Rightsourcing Tips from the Field," The CE, Vol 6, No 2, Summer 1998, 28.

377 Letha Cozart, "2000 Civil Engineer Worldwide Conference," The CE, Vol 8, No 4, Winter 2000-2001, 11

378 Maj. Drew Jeter, Maj. Drew Wright, and Capt. Jeffery Vinger, "The Air Force Civil Engineer Outsourcing and Privatization Program," The CE, Vol 4, No 4, Winter 1997, 12-13.

379 AFCEE, "U.S. Air Force Housing Privatization," accessed April 2011, www.afcee.af.mil/resources/housingprivatization/index.asp; Maj. Drew Jeter, Maj. Drew Wright, and Capt. Jeffery Vinger, "The Air Force Civil Engineer Outsourcing and Privatization Program," The CE, Vol 4, No 4, Winter 1997, 12-13.

380 AFCEE, "AFCEE's Role," accessed April 2011, www.afcee.af.mil/resources/housingprivatization/afceerole/index.asp.

381 Binks Franklin, "The Continuing Saga of Privatizing AF Family Housing," The CE, Vol 6, No 2, Summer 1998, 26.

382 "Air Force Tests New Legislation to Privatize Housing Construction," The CE, Vol 5, No 1, Spring 1997, 26.

383 Capt. Stacie A. Remy Vest, "Military Housing Privatization Initiative: A Guidance Document for Wading Through the Legal Morass," The Air Force Law Review, Vol 53, 2002, 10, accessed 9 March 2011, www.afjag.af.mil/shared/media/document/AFD-081204-025.pdf.

384 37th Training Wing Public Affairs, "Housing Privatization Gaining Ground at Lackland," The CE, Vol 6, No 3, Fall 1998, 12.

385 Binks Franklin, "The Continuing Saga of Privatizing AF Family Housing," The CE, Vol 6, No 2, Summer 1998, 26-27.

386 Rachel Fish, "Robins, Dyess Celebrate 10 Years of Housing Privatization," CenterViews, Vol 17, No 1, Jan-March 2011, 15.

387 National Transportation Safety Board, "Pipeline Accident Report: Natural Gas Explosion and Fire, Department of Defense/Army, Fort Benjamin Harrison, Indianapolis, Indiana, December 9, 1990," 8 April 1992, Files of the AFCESA History Office, Tyndall AFB, Florida.

388 "Defense Reform Initiative Directive # 9 – Privatizing Utility Systems," 10 December 1997, accessed April 2011, www.defense.gov/dodreform/drids.htm; "Defense Reform Initiative Directive # 49 – Privatizing Utility Systems," 23 December 1998, accessed April 2011, www.defense.gov/dodreform/drids.htm; TSgt. Michael Ward, "Why Privatize Utilities?," The CE, Vol 8, No 1, Spring 2000, 14.

389 Maj. Drew Jeter, Maj. Drew Wright, and Capt. Jeffery Vinger, "The Air Force Civil Engineer Outsourcing & Privatization Program," The CE, Vol 4, No 4, Winter 1997, 12; Maj. Jeff Vinger, "The New Air Force Utilities Privatization Process," The CE, Vol 5, No 4, Winter 1998, 8.

390 Brfg, Maj. Gregory A. Cummings, AFCESA, "Balancing Wartime Requirements and Utilities Privatization," Nov 1998; Lois E. Walker, History of the Air Force Civil Engineer Support Agency (RCS: HAF-HO[A]7101), 1 January – 31 December 1998, Chronology, n.p., AHO.

391 Memo, Gen. Michael E. Ryan, CSAF, to ALMAJCOM/CC and HQ USAFA/CC, Subj: Air Force Utilities Privatization Program Changes, 8 Feb 1999; Lizette Richardson, "Texas Utilities Privatization Underway," The CE, Vol 6, No 3, Fall 1998, 11; Lois E. Walker, History of the Air Force Civil Engineer Support Agency (RCS: HAF-HO[A]7101, 1 January – 31 December 1999, Chronology, 1999, n.p., AHO.

392 Maj. Bill Owens, "Utilities Privatization Update: Phase II," The CE, Vol 8, No 1, Spring 2000, 14; TSgt. Michael Ward, "Why Privatize Utilities?," The CE, Vol 8, No 1, Spring 2000, 14; Maj. Richard Doran and Capt. Bill Owens, "Utilities Privatization Update," The CE, Vol 7, No 1, Spring 1999, 11.

393 Maj. Richard Doran and Capt. Bill Owens, "Utilities Privatization Update," The CE, Vol 7, No 1, Spring 1999, 11.

394 Lois E. Walker, History of the Air Force Civil Engineer Support Agency (RCS: HAF-HO[A]7101), 1 January – 31 December 1998, Chronology, n.p., AHO.

395 Ibid.;Lois E. Walker, History of the Air Force Civil Engineer Support Agency (RCS: HAF-HO[A]7101), 1 January – 31 December 2000, Chronology, n.p., AHO.

396 Maj. Bill Owens, "Utilities Privatization Update: Phase II," The CE, Vol 8, No 1, Spring 2000, 14.

397 Frederick J. Shaw, “History’s Footprints: USAF Continental Bases,” Air Force Historical Research Agency, Maxwell AFB, Alabama, 2004, 153-60; “Base Realignment and Closure (BRAC),” accessed January 2010, www.globalsecurity.com.

398 Frederick J. Shaw, “History’s Footprints: USAF Continental Bases,” Air Force Historical Research Agency, Maxwell AFB, Alabama, 2004, 151-94.

399 TSgt. David P. Masko, “Base Transition,” CE Update, Vol 4, No 1, August 1992, 12.

400 Frederick J. Shaw, “History’s Footprints: USAF Continental Bases,” Air Force Historical Research Agency, Maxwell AFB, Alabama, 2004, 151-94

401 Ibid.

402 Maj. Gen. Eugene A. Lupia, “A Facility Strategy for Global Engagement,” TME, Vol 89, No 585, June-July 1997, 60-62.

403 Maj. Gen. James E. McCarthy (USAF, Retired), “Oral History Interview,” interview by Dr. Douglas H. Merkle and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, June 2005, 93.

404 Harry R. Fletcher, Air Force Bases Vol II: Air Bases Outside the United States of America, Center for Air Force History, U.S. Air Force, Washington, D.C., 1993, Appendix 2; Maj. Gen. Eugene A. Lupia, “A Facility Strategy for Global Engagement,” TME, Vol 89, No 585, June-July 1997, 60-62.

405 C.R. Anderegg, The Ash Warriors, Office of History, Pacific Air Forces, 2000; “Cops, Cooks, Civil Engineers: Fiery Vigil Challenges PACAF E&S Teams,” Engineering & Services Update, Vol 3, No 4, July-August 1991, 1-2; Dr. Ronald B. Hartzer, “Engineers and Natural Disaster Recovery,” The CE, Vol 3, No 3, Winter 1995, 27.

406 Walter J. Boyne, Beyond the Wild Blue: A History of the United States Air Force 1947-1997, St. Martin’s Press, New York, 417.

407 “Statement of John B. Goodman Deputy Under Secretary of Defense,” accessed March 2011, www.dod.gov/dodgc/olc/docs/test97-3-13Goodman.htm.

408 Sheila E. Widnall, “Report of the Secretary of the Air Force,” 1996, accessed March 2011, www.dod.gov/execsec/adr96/airforce_report.html; Maj. Gen. Eugene A. Lupia, “Maintaining the Readiness Core,” The CE, Vol 7, No 2, Summer 1999, 5.

409 Katie Halvorson, Maj. Scott Jarvis, and Capt. Jonathan Webb, “Unaccompanied Doesn’t Mean Uncomfortable,” The CE, Vol 4, No 4, Winter 1997, 18.

410 Ibid.; Robert E. Bayer, Deputy Assistant Secretary of Defense (Installations), “Military Housing Privatization Initiative” March 7 1996, Before the Subcommittee on Military Installations and Facility of the House Committee on National Security,” accessed 9 March 2010, www.dod.gov/pubs.

411 SSgt. Chris Miller, “Scott AFB Breaks Ground for First “1 Plus 1” Dormitory,” The CE, Vol 4, No 2, Summer 1996, 15.

412 Maj. Gen. Eugene A. Lupia, “From the Top: Planning for Our Future,” The CE, Vol 6, No 1, Spring 1998, 2.

413 Maj. Gen. Eugene A. Lupia, “Maintaining the Readiness Core,” The CE, Vol 7, No 2, Summer 1999, 5-6.

414 MSgt. Louis A. Arana-Barradas, “Enlisted to get Single Dorm Rooms,” The CE, Vol 2, No 8, Winter 1995, 8; Jean August, Herbert P. Carlin, William Elliott, Kathi R. Jones, Carol H. Parks, Layne B. Peiffer, William W. Suit, and John D. Webber, “History of the Air Force Materiel Command 1 October 1993-30 September 1994,” Volume XVII: Supporting Documents F-1—F-60, Office of the Command Historian, HQ Air Force Materiel Command, WPAFB, Ohio.

415 Binks Franklin, “The Continuing Saga of Privatizing AF Family Housing,” The CE, Vol 6, No 2, Summer 1998, 26.

416 Maj. Gen. James E. McCarthy, “Civil Engineering: Foundation of Air Force Readiness,” TME, Vol 87, No 571 June-July, 1995, 39; Maj. Gen. Eugene A. Lupia, “Forging Tomorrow’s Installations,” TME, Vol 88, No 578, June-July 1996, 46.

417 Maj. Gen. Eugene A. Lupia, “Planning for the Millennium,” TME, Vol 90, No 592, June-July 1998, 43.

418 Jean August, Herbert P. Carlin, William Elliott, Kathi R. Jones, Carol H. Parks, Layne B. Peiffer, William W. Suit, and John D. Webber, “History of the Air Force Materiel Command 1 October 1993-30 September 1994,” Volume XVII: Supporting Documents F-1—F-60, Office of the Command Historian, HQ Air Force Materiel Command, WPAFB, Ohio.

419 Maj. Gen. Eugene A. Lupia, “A Facility Strategy for Global Engagement,” TME, Vol 89, No 585, June-July 1997, 61.

420 AFPD 32-60, Housing, 9 July 1993, Muir S. Fairchild Research Information Center, Air University, Maxwell AFB, Alabama.

421 Maj. Gen. Eugene A. Lupia, “Forging Tomorrow’s Installations,” TME, Vol 88, No 578, June-July 1996, 47.

422 Warren Wright, Maj. Paul Vitucci, Bob Van Vonderen, and Jack Gibson, “CE Team: Supports Space Along the Eastern Range,” USAFCE, Vol 2, No 6, September-October 1994, 8; Patrick Air Force Base, “45SW Range and Launch Operations,” accessed March 2011, www.patrick.af.mil/library/factsheets.

423 Warren Wright, Maj. Paul Vitucci, Bob Van Vonderen, and Jack Gibson, “CE Team: Supports Space

Along the Eastern Range," USAFCE, Vol 2, No 6, September-October 1994, 8-9.

424 Ibid.

425 Ibid., 10.

426 Ibid.

427 Ibid.

428 Ibid.

429 Ibid.

430 Capt. Cynthia Rivera, "Vandenberg CEs Supports Space and Ballistic Launches," USAFCE, Vol 2, No 6, September-October 1994, 16-17.

431 Ibid.

432 Robert Mueller, Air Force Bases, Vol I, Active Air Force Bases Within the United States of America on 17 September 1982, 583-90, Office of Air Force History, Washington, D.C. 1989, 583-90; MSgt Michael A. Ward, "Back in Style: Base planners fashion new look for Whiteman AFB," Air Force Civil Engineer, Vol 11, No 4, Winter 2003, 18-21.

433 James Schumacher, "USAFE Drawdown Requires: Mildenhall Beddown," USAFCE, Vol 2, No 7, November-December 1994, 26-27.

434 Alan Riding, "Torrejon Journal; The F-16 Drama (Cont.): Happy Landing in Italy," The New York Times, 6 February 1990, accessed March 2011, www.nytimes.com/.

435 Lt. Col. Jack L. Johnson, Rebasing the 401st Tactical Fighter Wing—Here, There, or Anywhere?, prepared for the National War College, 22 February 1990, 1, accessed March 2011, www.dtic.mil/.

436 Ralph E. Jackson, "Relocating the 401st Tactical Fighter Wing," Thesis, AFIT, University of Maryland, College Park, 3 May 1991, 7, accessed March 2011, www.dtic.mil/.

437 "New NATO Air Base Project Causes Controversy," The Washington Post, 10 June 1990, accessed March 2011, http://articles.dailypress.com/1990-06-10/news/9006100051_1_air-base-military-families-base-construction

438 Lt. Col. Douglas M. Fraser, "Memorandum for General McPeak," 11 October 1990, Files of Air Force Historical Research Agency, Maxwell AFB, Alabama; Lt. Col. Jack L. Johnson, Rebasing the 401st Tactical Fighter Wing—Here, There, or Anywhere?, National War College, 22 February 1990, 4, accessed March 2011, www.dtic.mil/.

439 William M. Butler and Lt. Col. Glen W. Moorhead III, "History of Headquarters Sixteenth Air Force 1 January 2003-31 December 2003 Assigned to United States Air Forces in Europe Stationed at Aviano Air Base," Italy, 26 January 2005, Files of Air Force Historical Research Agency, Maxwell AFB, Alabama.

440 TSgt. Niklaas A. Waller, Fifty Years of Friendship and Cooperation A History of Aviano Air Base 1955-2005, Office of History, HQ 31st Fighter Wing Aviano AB, 1 February 2005, 6-7.

441 Louis Arna-Barradas, "Aviano Undergoes Renaissance," Airman Magazine, November 2000, accessed March 2011, www.af.mil/news/story.asp?id=123069313.

442 Lt. Col. Marvin Fisher and Capt. Jeff Mathieu, "Aviano 2000 Developing the "Jewel of the Mediterranean," The CE, Vol 5, No 4, Winter 1998, 10.

443 Jim Weslowski, "Aviano Today," The CE, Vol 10, No 3, Fall/Winter 2002, 4-9.

444 Lt. Col. Marvin Fisher and Capt. Jeff Mathieu, "Aviano 2000 Developing the 'Jewel of the Mediterranean,'" The CE, Vol 5, No 4, Winter 1998, 10; Louis Arna-Barradas, "Aviano Undergoes Renaissance," Airman Magazine, November 2000, accessed March 2011, www.af.mil/news/story.asp?id=123069313.

445 William M. Butler and Lt.Col. Glen W. Moorhead III, "History of Headquarters Sixteenth Air Force 1 January 2003-31 December 2003 Assigned to United States Air Forces in Europe Stationed at Aviano Air Base," Italy, 26 January 2005, Files of Air Force Historical Research Agency, Maxwell AFB, Alabama.

446 History of the United States Air Forces in Europe, 1 Jan-31 Dec 1998, 88-89; "Putting People First: An Interview with The Air Force Civil Engineer, Maj. Gen. L. Dean Fox," The Air Force Civil Engineer, Vol 11, No 2, Summer 2003, 8.

447 David M. Johnson, "Rebuilding Ramstein: Force Realignment Requires New Mission Beddown," The CE, Vol 5, No 2, Summer 1997, 8-11.

448 "Beddown Projects Underway," The CE, Vol 2, No 8, Winter 1995, 33; David M. Johnson, "Rebuilding Ramstein: Force Realignment Requires New Mission Beddown," The CE, Vol 5, No 2, Summer 1997, 8-11.

449 David M. Johnson, "Rebuilding Ramstein: Force Realignment Requires New Mission Beddown," The CE, Vol 5, No 2, Summer 1997, 8-9.

450 "The Schoolhouse: AFIT Will Bring it to You," USAFCE, Vol 1, No 5, July 1993, 2.

451 Capt. Greg Schmidt, "New AFIT Building: Not Just a Building—a Teaching Tool," USAFCE, Vol 1, No 8, November 1993, 6-7; "Moving Experience: New AFIT Schoolhouse Almost Ready," USAFCE, Vol 2, No 7, November-December 1994, 21.

452 AFIT, "The Civil Engineer School at the Air Force Institute of Technology, History," accessed March 2011, www.afit.edu; Lt. Col. Mark Goltz, "Air Force Institute of Technology, Engineering and Environmental Management Program Update," USAFCE, Vol 1, No 5, July 1993, 17.

453 Maj. John A. Arin, "New Emphasis on Early Education of CEs: Initial Skills Training at AFIT," USAFCE, Vol 2, No 7, November-December 1994, 12-13.

454 Ibid.

455 Ibid., 13.

456 Lt. Col. Alfred E. Thal, "The GEEM Program, Graduate Education with an Air Force Focus," Air Force Civil Engineer, Vol 9, No 2, Summer 2001, 18.

457 Lt. Col. Alfred E. Thal, "The GEEM Program, Graduate Education with an Air Force Focus," Air Force Civil Engineer, Vol 9, No 2, Summer 2001, 18; Lt. Col. Steven T. Lofgren, Lt. Col. Michael L. Shelley, and Maj. W. Brent Nixon, "GEEM at AFIT," The CE, Vol 4, No 2, Summer 1996, 30.

458 Lt. Col. Steven T. Lofgren, Lt. Col. Michael L. Shelley, and Maj. W. Brent Nixon, "GEEM at AFIT," The CE, Vol 4, No 2, Summer 1996, 30.

459 Ibid., 30-31.

460 Ibid., 31-33.

461 Capt. Karla K. Mika, "AFIT: One Student's Perspective," The CE, Vol 5, No 2, Summer 1997, 35.

462 Lt. Col. Mike Duncan, "Graduate Education for CE Professionals," The CE, Vol 4, No 2, Summer 1996, 32-33.

463 Ibid.

464 Ibid.

465 Barbara Bryant, "Academy Cadets Launch into New Training," The CE, Vol 2, No 8, Winter 1995, 20.

466 Ibid.

467 Ibid., 31.

468 Ibid.

469 "AFCESA History: Inter-service Training Review Organization," 1993, n.p., AHO; SMSgt. Frank Vandevander, "Consolidated CE Training in Military's Future," The CE, Vol 3, No 2, Summer 1995, 45.

470 AFCESA History: Implementation of AF/CC Year of Training (YOT) Initiatives, 1992, n.p., AHO; "CFETP – The Roadmap to a Successful Career," The CE, Vol 4, No 1, 28.

471 Lt. Col. Allen W. Poerner, "Doing more with less…the smart way," The CE, Vol 5, No 1, Spring 1997, 28-29; AFCESA History: Implementation of AF/CC Year of Training (YOT) Initiatives, 1992, n.p., AHO; Maj. Andy Johnson, "Training to Succeed," The CE, Vol 5, No 2, Summer 1997, 34-35.

472 CMSgt. Chuck Perry and the STTC Team, "USAF Civil Engineering Training—Leading the Way!," USAFCE, Vol 1, No 7, September-October 1993, 12-13.

473 Ibid., 14-15.

474 "Fire Academy History," from the AHO; Douglas E. Courchene, Pioneers with Intent, Memoirs of an Air Force Fire Fighter, Air Force Civil Engineer Support Agency, Tyndall AFB July 2003, 62.

475 "EOD School Consolidated at Eglin," The CE, Vol. 7 No. 1, Spring 1999, 29; Lt. Col. Tom Dombrowsky, "EOD Memorial Moves to Eglin," The CE, Vol 7, No 4, Winter 1999-2000, 32.

476 Dr. Ronald B. Hartzer, "A History of the Tyndall Silver Flag Exercise Site," n.d., AHO; Col. Marshall W. Nay, Jr., "What's In a Name?," CE Update, Vol 3, No 4, December 1991, 6-7; Perry Sullivan, "Silver Flag Site: RED HORSE Takes Over Silver Flag Site," USAFCE, Vol 1, No 6, August 1993, 2; Brig. Gen. Michael McAuliffe, "Telecon on Genesis of the Silver Flag Exercise Site," with Lois Walker and Dr. Merkle, 19 September 2002, 2-3, AHO.

477 Maj. Daniel P. Gosselin and Maj. Timothy R. McLean, "Silver Flag Exercise Site Program: Readiness Training for the Future," USAFCE, Vol 1, No 6, August 1993, 4-5.

478 Ibid.

479 CMSgt. David A. Bolin, "Key Changes Made: Curriculum Used at Silver Flag Exercise Site Validated by Study Panel," USAFCE, Vol 2, No 1, February 1994, 2-3.

480 Maj. Daniel P. Gosselin and Maj. Timothy R. McLean, "Silver Flag Exercise Site Program: Readiness Training for the Future," USAFCE, Vol 1, No 6, August 1993, 4-5.

481 Teresa Hood, "Guard Provides Hands-On Training," Air Force Civil Engineer, Vol 13, No 4, 2005, 6; CMSgt McLeod, "Point Paper on Regional Equipment Operator Training Site Concept," 6 September 1989, AHO.

482 CMSgt McLeod, "Point Paper on Regional Equipment Operator Training Site Concept," 6 September 1989, AHO; CMSgt Robert K. Williams, "Readiness Update, Validation of the Regional Operators Training Sites," Air Force Engineering & Services Update, Vol 3, No 1, January 1991, 16; Teresa Hood, "Guard Provides Hands-On Training," Air Force Civil Engineer, Vol 13, No 4, 2005, 6.

483 Perry Sullivan, "Expedient Repairs Score Well in SAC, PACAF Demonstrations,", CE Update," Vol 3, No 4, December 1991, 26; Capt. Nick Desport, "15th CES Supporting Foal Eagle," U.S. Air Force Civil Engineer, Vol 2, No 4, May-June 1994, 18-19.

484 TSgt. Darla J. Ernst, "Eielson Engineers Keep Tent City Running Smoothly," The CE, Vol 5, No 4, Winter 1998, 31.

485 Capt. Nick Desport, "15th CES Supporting Foal Eagle," USAFCE, Vol 2, No 4, May-June 1994, 18-19.

486 TSgt. Steven C. Prier, "Civil Engineers Participate in Exercise Green Flag 95," The CE, Vol 3, No 3, Winter 1995, 26.

487 Capt. D. Scott Vaughn, "Return to Cambodia," The CE, Vol 4, No 4, Winter 1997, 20-21.

488 Ibid.

489 Brig. Gen. James E. McCarthy, "Readiness Challenge: BEST EVER!," USAFCE, Vol 1, No 4, May-June 1993, 11.

490 Maj. Gen. James E. McCarthy (USAF, Retired), "Oral History Interview," interview by Dr. Douglas H.

Merkle and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, June 2005, 71; Brig. Gen. James E. McCarthy, "Readiness Challenge: BEST EVER!," USAFCE, Vol 1, No 4, May-June 1993, 14-15; "Det 1 Relocates to Tyndall," Official Newspaper of Readiness Challenge IV, Vol 3, No 2, April 25, 1993, 3-5, AHO.

491 TSgt. Andra Higgs, "Let the Games Begin!," The CE, Vol 3, No 2, Summer 1995, 24-26.

492 Ibid.; TSgt Andra Higgs, "Services Competes in RC-V," The CE, Vol 3, No 2, Summer 1995, 32-33.

493 TSgt. Eddie C. Riley, "RC-VI Committee: Plans Well Under Way," The CE, Vol 4, No 3, Fall 1996, 9; Maj. Gen. Eugene A. Lupia, "From the Top, Readiness Challenge Winners," The CE, Vol 5, No 1, Spring 1997, 2; Sue Alexander, "Chaplains Provide Spiritual Support at RC-VI," The CE, Vol 5, No 1, Spring 1997, 24; Sue Alexander, "RIBS At the Ready," The CE, Vol 5, No 1, Spring 1997, 24; Sue Alexander, "We Are Ready!," The CE, Vol 5, No 1, Spring 1997, 14-15.

494 See note above.

495 Sue Alexander, "We Are Ready!," The CE, Vol 5, No 1, Spring 1997, 16-17; Maj. Gen. Eugene A. Lupia, "From the Top, Readiness Challenge Winners," The CE, Vol 5, No 1, Spring 1997, 2.

496 "When Duty Calls…Balkan Operations Put Readiness Challenge VII on Hold," The CE, Vol 7, No 2, Summer 1999, 22-23.

497 Col. Frank J. Destadio,"Focus on Team-Building," The CE, Vol 6, No 1, Spring 1998, 6; Maj. Gen. Eugene A. Lupia, "From the Top, Readiness Challenge Winners," The CE, Vol 5, No 1, Spring 1997, 2.

498 Brig. Gen. Michael A. McAuliffe, "Oral History Interview," interview by Dr. Ronald B. Hartzer, Duane Knutson, and Norm Falk, HQ AFCESA, Tyndall AFB, Florida, July 1991, 10.

499 Ronald L. Smith, "Organizing Air Force Civil Engineers For Peace, War, and Military Operations Other Than War (MOOTW)," Research Report, Air War College, Maxwell AFB, Alabama, 1996, 13.

500 "Reflecting on a Dynamic Career," The CE, Vol 4, No 3, Fall 1996, 6-7.

501 Maj. Gen. Earnest O. Robbins II, "We're All on the Same Team," The CE, Vol 8, No 3, Fall 2000, 2.

502 Perry D. Jamieson, Lucrative Targets: The U.S. Air Force in the Kuwaiti Theater of Operations, Air Force History and Museums Programs, USAF, Washington, D.C., 2001, 1-4; Col. Walter J. Boyne (USAF, Retired), Beyond the Wild Blue, St. Martin's Press, New York, 1997, 290-294.

503 Col. Walter J. Boyne (USAF, Retired), Beyond the Wild Blue, St. Martin's Press, New York, 1997, 297; Perry D. Jamieson, Lucrative Targets: The U.S. Air Force in the Kuwaiti Theater of Operations, Air Force History and Museums Programs, USAF, Washington, D.C., 2001, 9.

504 Perry D. Jamieson, Lucrative Targets: The U.S. Air Force in the Kuwaiti Theater of Operations, Air Force History and Museums Programs, USAF, Washington, D.C., 2001, 7.

505 Col. Walter J. Boyne (USAF, Retired), Beyond the Wild Blue, St. Martin's Press, New York, 1997, 299, 301,308; "General Ahearn Briefs New Civil Engineering, Services Order," Engineering & Services Update, Vol 3, No 2, February-March 1991, 1.

506 Brig. Gen. Michael A. McAuliffe, "Oral History Interview," interview by Dr. Ronald B. Hartzer, Norm Falk, and Duane Knutson, HQ TAC/DE, Langley AFB, Virginia, July 1991, 2. When General McAuliffe retired from the Air Force in 1994, the annual award for the outstanding Housing Flight was named in his honor.

507 "Newman Medal Goes to Colonel Rothenberg," Engineering & Services Update, Vol 3, No 2, February-March 1991, 21.

508 Ibid.

509 Maj. Gen. Joseph A. Ahearn (USAF, Retired), "Oral History Interview," interview by Dr. Douglas H. Merkle and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, March 2008, 83-84.

510 "ATC E&S Conference: Center's Support to Desert Shield/Storm Outlined," Engineering & Services Update, Vol 3, No 3, May-June 1991, 1.

511 H. Perry Sullivan, Jr., "Gilbert Winners Cited for Staff Excellence," Engineering & Services Update, Vol 3, No 2, February-March, 1991, 23; H. Perry Sullivan, "Southwest Asia: HQ AFESC Responds to Crisis in the Persian Gulf," Engineering & Services Update, Vol 2, No 8, September 1990, 1, 3.

512 H. Perry Sullivan, "Around-the-Clock, 6 Weeks, Operation Desert Shield," Engineering & Services Update, Vol 2, No 8, September 1990, 2-3; "Operation Desert Shield," Engineering & Services Update, Vol 2, No 9, November 1990, 17.

513 Maj. Gen. Joseph A. Ahearn (USAF, Retired), "Oral History Interview," interview by Dr. Douglas H. Merkle and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, March 2008, 83-84.

514 H. Perry Sullivan, "Southwest Asia: HQ AFESC Responds to Crisis in the Persian Gulf," Engineering & Services Update, Vol 2, No 8, September 1990, 1.

515 Ibid.; H. Perry Sullivan, "Around-the-Clock, 6 Weeks, Operation Desert Shield," Engineering & Services Update, Vol 2, No 8, September 1990, 2-3.

516 Directorate of Readiness, "Weekly Activity Report," 9 Jan 91, Files of the AFCESA History Office, Tyndall AFB, Florida; "Desert Shield Equipment Buy," Engineering & Services Update, Vol 2, No 9, November 1990, 17.

517 "New Mobile Kitchen Developed for Desert Storm," Engineering & Services Update, Vol 3, No 2, February-March 1991, 10.

518 H. Perry Sullivan, "Southwest Asia: HQ AFESC Responds to Crisis in the Persian Gulf," Engineering & Services Update, Vol 2, No 8, September 1990, 1; H. Perry Sullivan, "Around-the-Clock, 6 Weeks, Operation Desert Shield," Engineering & Services Update, Vol 2, No 8, September 1990, 2-3.

519 "Folded Fiberglass Mats: AFESC Team Goes to Desert Shield," Engineering & Services Update, Vol 2, No 9, November 1990, 3.

520 Maj. Gen. Joseph A. Ahearn, "General Ahearn Comments on Desert Shield," Engineering & Services Update, Vol 2, No 8, September 1990, 3.

521 Dr. Ronald B. Hartzer, "Gulf War History," n.d., 23-24, AHO.

522 Ibid., 60-63.

523 Maj. David Sanders, Lt. Joel Holtrop, and Lt. Brian Duffy, "Oral History Interview," interview by Dr. Ronald B. Hartzer, HQ AFCESA, Tyndall AFB, Florida, 25 Sep 1991, 6

524 "Readiness Update," Air Force Engineering and Services Center, Engineering & Services Update, Vol 3, No 2, February-March 1991, 25.

525 H. Perry Sullivan, "Brig. Gen. Eugene A. Lupia, Deputy Chief of Staff, Civil Engineering HQ Air Mobility Command, Scott AFB, Illinois," CE Update, Vol 4, No 2, November 1992, 21-22.

526 Dr. Ronald B. Hartzer, "Gulf War History," n.d., 17, AHO.

527 Gen. Robert H. Scales, Certain Victory: The US Army in the Gulf War, US Army Command and General Staff College Press, Fort Leavenworth, Kansas, 1994, 43; Capt. Wayland H. Patterson, "Oral History Interview," interview by Dr. Ronald B. Hartzer, HQ AFCESA, Tyndall AFB, Florida, July 1991, 6.

528 Capt. Wayland H. Patterson, "Oral History Interview," interview by Dr. Ronald B. Hartzer, HQ AFCESA, Tyndall AFB, Florida, July 1991, 6.

529 Col. Wayne McDermott, "Role of Engineering & Services in Operation Desert Shield/Storm," Briefing for Space Command, n.d., AHO; Lt. Col. David J. Ruschmann, "Air Force Engineering and Services Participation in Operation Desert Shield from a TAC Engineering and Services Readiness Planners Perspective," Jul-Sep 1990, n.p, AHO.

530 Lt. Col. David J. Ruschmann, "Air Force Engineering and Services Participation in Operation Desert Shield from a TAC Engineering and Services Readiness Planners Perspective," Jul-Sep 1990, n.p., AHO.

531 Ibid.

532 Lt. Col. David J. Ruschmann, "Air Force Engineering and Services Participation in Operation Desert Shield from a TAC Engineering and Services Readiness Planners Perspective,"Jul-Sep 1990, n.p., AHO; Gen. Robert H. Scales, Certain Victory: The US Army in the Gulf War, US Army Command and General Staff College Press, Fort Leavenworth, Kansas, 1994, 44.

533 Lois Walker, "Gulf War Retrospective," Air Force Civil Engineer, Vol 9, No 1, Spring 2001, 7.

534 Department of the Air Force, Air Force Pamphlet 10-219, Bare Base Conceptual Planning Guide, Vol 5, 1 June 1996, 21.

535 Ibid., 22.

536 Ibid., 37.

537 Capt. Marvin N. Fisher, "Oral History Interview," interview by Dr. Ronald B. Hartzer, HQ AFCESA, Tyndall AFB, Florida, August 1991, Introduction, 4.

538 Ibid.

539 Ibid., 5-6.

540 Ibid., 6.

541 SSgt. Detroit Whiteside, "Others Promise; They Produce," Engineering & Services Update, Vol 2, No 8, November 1990, 1-2; Dr. Ronald B. Hartzer, "Gulf War History," n.d., 21, AHO.

542 Capt. Wayland H. Patterson, "Oral History Interview," interview by Dr. Ronald B. Hartzer, HQ AFCESA, Tyndall AFB, Florida, 10 July 1992, 42.

543 Capt. Marvin N. Fisher, "Oral History Interview," interview by Dr. Ronald B. Hartzer, HQ AFCESA, Tyndall AFB, Florida 12, August 1991, 23.

544 Lt. Col. Rodney L. Hunt, "Oral History Interview," interview by Dr. Ronald B. Hartzer and Duane Knutson, HQ AFCESA, Tyndall AFB, Florida, September 1991, 5-8.

545 Ibid., 8.

546 MSgt William L. Hinegardner, "Oral History Interview," interview by Dr. Ronald B. Hartzer, HQ AFCESA, Tyndall AFB, Florida, December 1990, 22.

547 Dr. Ronald B. Hartzer, "Gulf War History," n.d., 21-22, 24, AHO; "RED HORSE in Desert Shield/Storm," n.d., n.p, AHO.

548 "820th RED HORSE Squadron Deployment Summary 1987-2009," n.d., 2, AHO.

549 Department of the Air Force, Headquarters U.S. Air Force, AF Regulation 93-9, 15 April 1983, 10.1, 13.

550 Ibid.; 13; "RED HORSE Realignment," PowerPoint Presentation, 1996, AHO.

551 See note above.

552 See note above.

553 Lt. Col. Ronald P. McCoy, "Oral History Interview," interview by Dr. Ronald B. Hartzer, HQ AFCESA, Tyndall AFB, Florida, August 1991, 6-7, 26.

554 Col. Thomas F. Wilson, "Oral History Interview," interview by Dr. Ronald B. Hartzer, Duane Knutson, and Peter Hart, HQ AFCESA, Tyndall AFB, Florida, October 1991, 5, 7, 8.

555 "Desert Shield/Desert Storm, 823 RED HORSE CES, After Action Report," n.d., n.p., AHO.

556 Maj. Timothy Bridges, "Oral History Interview," interview by Dr. Ronald B. Hartzer and Duane

Knutson, HQ AFCESA, Tyndall AFB, Florida, 1 August 1991, 29.

557 "Shaikh Isa," AHO.

558 United States Central Command Air Forces (USCENTAF/DE) Engineering & Services, History Volume I, (CENTAF/DE, AFCOMS, CEMIRT, Mortuary, RED HORSE), Operation Desert Storm, Col. Rothenberg C+120 to C+150, n.d., n.p., AHO; Col. Thomas F. Wilson, "Oral History Interview," interview by Dr. Ronald B. Hartzer, Duane Knutson, and Peter Hart, HQ AFCESA, Tyndall AFB, Florida, October 1991, 5.

559 United States Central Command Air Forces (USCENTAF/DE) Engineering & Services, History Volume I, (CENTAF/DE, AFCOMS, CEMIRT, Mortuary, RED HORSE), Operation Desert Storm, 14 March 1991 "After Action Report – 823 RED HORSE Civil Engineering Squadron Deployed" To HQ CENTAF/DE, n.d., n.p., AHO.

560 Capt. Chris Unger, "Profile of a Winner: Whiteman Earns Curtin Award," CE Update, Vol 4, No 2, August 1992, 18.

561 Lt. Col. Alfred B. Hicks, Jr., "Oral History Interview," interview by Dr. Ronald B. Hartzer and Duane Knutson, HQ AFCESA, Tyndall AFB, Florida, 23 January 1992, 7.

562 Ibid.,10.

563 Ibid.

564 Capt. Wayland H. Patterson, "Oral History Interview," interview by Dr. Ronald B. Hartzer, HQ AFCESA, Tyndall AFB, Florida, 10 July 1992,44.

565 Capt. Mark D. Wright, "Civil Engineering Lessons Learned Report, 1640th TAWP/DE, Operations Desert Shield and Desert Storm," for HQ TAC BS/DE 27 March 1991, AHO.

566 TSgt. Dale Warman, "Bare Base Work Continues," AHO.

567 United States Central Command Air Forces (USCENTAF/DE) Engineering & Services History Volume 1 (CENTAF/DE, AFCOMS, CEMIRT, MORTUARY, RED HORSE) Operation Desert Storm, AHO.

568 After Action Report, CMSgt Hans Finkbeiner, USCENTAF/DE, 7 Oct 90 to 1 Mar 91, Files of the AFCESA History Office, Tyndall AFB, Florida; Interview, Maj. David Sanders, 22d CES, with Dr Ronald B. Hartzer, 25 Sep 91, Files of the AFCESA History Office, Tyndall AFB, Florida.

569 Capt. Mark D. Wright, "Civil Engineering Lessons Learned Report, 1640th TAWP/DE, Operations Desert Shield and Desert Storm," for HQ TAC BS/DE 27 March 1991, AHO.

570 TSgt. William Caballero, "1701 AFREFW(P) Fire Protection History at Jeddah AB, AHO.

571 Dr. Ronald B. Hartzer, "Gulf War History," n.d., 41, AHO; Lt. Col. Timothy Beally, "Oral History Interview," interview by Dr. Ronald B. Hartzer, Duane Knutson, Jim Rosa, and Peter Hart, 27 Aug 91, Files of the AFCESA History Office, Tyndall AFB, Florida; New Mexico Engineering Research Institute, Lessons Learned by Civil Engineering, Services, Air Base Operability, Disaster Preparedness, and Explosive Ordnance Disposal during Desert Shield/Desert Storm Proven Force/Provide Comfort, prepared for Deputy Chief of Staff for Civil Engineering Headquarters, Air Combat Command and Headquarters Air Force Civil Engineering Support Agency, Volume II, 1992, 207.

572 Dr. Ronald B. Hartzer, "Engineering and Services in Operation Desert Shield," CE Update, Vol 3, No 4, December 1991, 27.

573 New Mexico Engineering Research Institute, Lessons Learned by Civil Engineering, Services, Air Base Operability, Disaster Preparedness, and Explosive Ordnance Disposal during Desert Shield/Desert Storm Proven Force/Provide Comfort, prepared for Deputy Chief of Staff for Civil Engineering Headquarters, Air Combat Command and Headquarters Air Force Civil Engineering Support Agency, Volume I, 1992, 68.

574 Dr. Ronald B. Hartzer, "Lessons Learned: Desert Shield/Storm Study Complete," USAFCE, Vol 1, No 3 April 1993, 18.

575 New Mexico Engineering Research Institute, "Part G-Explosive Ordnance Disposal," Lessons Learned by Civil Engineering, Services, Air Base Operability, Disaster Preparedness, and Explosive Ordnance Disposal during Desert Shield/Desert Storm Proven Force/Provide Comfort, prepared for Deputy Chief of Staff for Civil Engineering Headquarters, Air Combat Command and Headquarters Air Force Civil Engineering Support Agency, Volume I, 1992, II 272-302.

576 Point Paper, "Harvest Falcon Desert Shield Assets," Larry Kalivoda, HQ AFESC/DEOP, 5 Oct 90; CENTAF/DE, "Weekly Status Report," 19 January 1991.31. Personal History, Lt. Col. Ronald P. McCoy, CENTAF/DE, 7 Sep 90 - 6 Oct 90, Files of the AFCESA History Office, Tyndall AFB, Florida.

577 Dr. Ronald B. Hartzer, "Gulf War History," n.d., 34, 47, AHO; Lt. Col. Ronald P. McCoy, "Oral History Interview," interview by Ronald B. Hartzer, HQ AFCESA, Tyndall AFB, Florida, August 1991, 6.

578 Lt. Col. Ronald P. McCoy, "Oral History Interview," interview by Dr. Ronald B. Hartzer, HQ AFCESA, Tyndall AFB, Florida, August 1991, 20; Maj. David Sanders, Lt. Joel Holtrop, and Lt. Brian Duffy, "Oral History Interview," interview by Dr. Ronald B. Hartzer, HQ AFCESA, Tyndall AFB, Florida, September 1991, 19; Capt. Jeffrey Byer, "Oral History Interview," interview by Dr. Ronald B. Hartzer, HQ AFCESA, Tyndall AFB, Florida, July 1991, 18-19; Lt. Col. Alfred B. Hicks, Jr., "Oral History Interview," interview by Dr. Ronald B. Hartzer, HQ AFCESA, Tyndall AFB, Florida, January 1992, 64.

579 Col. Wayne McDermott, "Role of Engineering & Services in Operation Desert Shield/Storm," Briefing for Space Command, n.d., n.p., AHO.

580 Dr. Ronald B. Hartzer, "Gulf War History," n.d., 34, 47, AHO; New Mexico Engineering Research Institute, Lessons Learned by Civil Engineering, Services, Air Base Operability, Disaster Preparedness, and

Explosive Ordnance Disposal during Desert Shield/Desert Storm Proven Force/Provide Comfort, Vol I, "Part C – Services," Prepared for Deputy Chief of Staff for Civil Engineering Headquarters, Air Combat Command, and Headquarters Air Force Civil Engineering Support Agency, 1992, II-157; "ATC E&S Conference: Center's support to Desert Shield/Storm Outlined," Engineering & Services Update, Vol 3, No 3, May-June 1991, 3; Col. Wayne McDermott, "Role of Engineering & Services in Operation Desert Shield/Storm," Briefing for Space Command, n.d., n.p, AHO.

581 "USAF Port Mortuary, Dover AFB, DE, Desert Shield/Desert Storm, After Action Report," 1 June 91, pp 1-3

582 Ibid., pp 5-7

583 Ibid., pp 3-5

584 "ATC E&S Conference: Center's Support to Desert Shield/Storm Outlined," Engineering & Services Update, Vol 3, No 3, May-June 1991, 1-2; Jack Struebing, "Bullet Background Paper on Harvest Bare Power Distribution Centers," 31 August 1990, AHO.

585 "ATC E&S Conference: Center's Support to Desert Shield/Storm Outlined," Engineering & Services Update, Vol 3, No 3, May-June 1991, 1-2.

586 Ibid.

587 Joseph H. Smith, "Oral History Interview," interview by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, November 2004, 49; "ATC E&S Conference: Center's Support to Desert Shield/Storm Outlined," Engineering & Services Update Vol 3, No 3, May-June 1991, 1-2.

588 United States Central Command Air Forces (USCENTAF/DE) Engineering & Services, History Volume I, (CENTAF/DE, AFCOMS, CEMIRT, Mortuary, RED HORSE), Operation Desert Storm, Col. Rothenberg C+120 to C+150, n.d., n.p., AHO.

589 Dr. Ronald B. Hartzer, "Al Kharj AB: The Model Bare Base Beddown," The CE, Vol 5, No 2, Summer 1997, 25.

590 Maj. Richard Norris, "Oral History Interview," interview by Dr. Ronald B. Hartzer, Duane Knutson, and MSgt. David Beal, HQ AFCESA, Tyndall AFB, Florida, October 1991, 17.

591 Ibid.

592 Ibid., 47.

593 HQ USAFE ES&ABO, "The Tip of the Sword: We Keep the Fighters in the Fight," 3 January 1992, 13-17, AHO..

594 Ibid.

595 Ibid., 18, AHO.; Capt. Donald Gleason, "Bullet Background Paper on Mobility Training Requirements," 6 December 1991, AHO.

596 HQ USAFE ES&ABO, "The Tip of the Sword: We Keep the Fighters in the Fight," 3 January 1992, 6, AHO.

597 . "820th RED HORSE Desert Shield/Desert Storm After Action Report," 1991, AHO.

598 Dr. Ronald B. Hartzer, "Gulf War History," n.d., 81-82, AHO; Col. Thomas F. Wilson, "Oral History Interview," interview by Dr. Ronald B. Hartzer, Duane Knutson, and Peter Hart, HQ AFCESA, Tyndall AFB, Florida, October 1991, 23.

599 "1965-2000 RED HORSE Hall of History Dedication and 'I Was There' Symposium, 35 Years of Excellence," 2000, n.p, AHO; "Desert Shield/Desert Storm 823 RED HORSE CES After Action Report, Tab F, Operation Desert Finale, AHO.

600 Lois Walker, "Gulf War Retrospective," Air Force Civil Engineer, Vol 9, No 1, Spring 2001, 7-8; Dr. Ronald B. Hartzer, "Gulf War History," n.d., 81-82, AHO; Maj. Raymond Bruce Torgerson, "Services Readiness Came of Age," CE Update, Vol 3, No 4, December 1991, 11.

601 United States Central Command Air Forces (USCENTAF/DE) Engineering & Services, History Volume I, (CENTAF/DE, AFCOMS, CEMIRT, Mortuary, RED HORSE), Operation Desert Storm, 363 CES History Report (3 Feb – 4 March), Recorded by Lt. Jim McEachen, Al Dhafra, n.d., n.p., AHO; Lt. Col. Timothy Beally, "Oral History Interview," interview by Dr. Ronald B. Hartzer, Duane Knutson, Jim Rosa, and Peter Hart, HQ AFCESA, Tyndall AFB, Florida, August 1991, 53; 1st Lt. Michele Madden, "What Goes Up Comes Down," Engineering & Services Update, Vol 3, No 2, Feb-March 1991, 2.

602 Lt. Col. Timothy Beally, "Oral History Interview," interview by Dr. Ronald B. Hartzer, Duane Knutson, Jim Rosa, and Peter Hart, 2d Civil Engineering Squadron, Barksdale AFB, Louisiana, 27 August 1991, 53.

603 1st Lt. Michele Madden, "What Goes Up Comes Down," Air Force Engineering and Services Center, Engineering & Services Update, Vol 3, No 2, February-March 1991, 2.

604 Lt. Col. Alfred B. Hicks, Jr., "Oral History Interview," interview by Dr. Ronald B. Hartzer, HQ AFCESA, Tyndall AFB, Florida, January 1992, 40.

605 Capt. Steven T. Rose, "Operation Provide Comfort: An Engineer's Show," USAFCE, Vol 1, No 1, February 1993, 17; Dr. Ronald B. Hartzer, "Gulf War History," n.d., 83, AHO.

606 See note above.

607 See note above.

608 Capt. Steven T. Rose, "Operation Provide Comfort: An Engineer's Show," USAFCE, Vol 1, No 1, February 1993, 17-18; Ronald J. Brown, Humanitarian Operations in Northern Iraq, 1991: With Marines in Operation Provide Comfort, History and Museums Division Headquarters, US Marine Corps, Washington, DC,

1995, 37; Capt. Jonathan Driskill, "36th CES Getting the Job Done," Bitburg Skyblazer, October 1991, 23; Gordon W. Rudd, Humanitarian Intervention: Assisting the Iraqi Kurds in Operation Provide Comfort, 1991, U.S. Army Center of Military History, Washington, DC, 2004, 52-56.

609 Capt. Steven T. Rose, "Operation Provide Comfort: An Engineer's Show," USAFCE, Vol 1, No 1, February 1993, 23.

610 Ibid., 21-22; Capt. Jonathan Driskill, "36th CES Getting the Job Done," Bitburg Skyblazer, October 1991, 23.

611 Lt. Col. Alfred B. Hicks, Jr., "Oral History Interview," interview by Dr. Ronald B. Hartzer, HQ AFCESA, Tyndall AFB, Florida, January 1992, 37.

612 Capt. Eric S. Turner, "Operation Pacific Haven," The CE, Vol 5, No 1, Spring 1997, 34-35.

613 Ibid.

614 Ibid.

615 Philip Shenon, "23 U.S. Troops Die in Truck Bombing in Saudi Base," NY Times, 26 June 1996, accessed March 2011, http://partners.nytimes.com/library/world/africa/062696binladen.html.

616 Lt. Col. Robbin Schellhous, "I Was There When the Bomb Went Off…," The CE, Vol 4, No 3, Fall 1996, 32.

617 Ibid., 33; Perry D. Jamieson, Khobar Towers: Tragedy and Response, Washington DC, 2008, 43-52, 210-11.

618 Sr. MSgt. Jim Katzaman, "Secretary of Defense Issues Khobar Towers Findings," Air Force News Service, 1 August 1997, accessed March 2011, www.au.af.mil/au/awc/awcgate/khobar/n19970801_970946.htm.

619 Sue Alexander, "We Build It and They Will Come," The CE, Vol 4, No 3, Fall 1996, 15.

620 United States Air Force, Air Force Handbook 10-222 Civil Engineer Guide to Expeditionary Force Protection, Vol 3, 1 May 2008, 18.

621 Lt. Col. Myron L. Freeman, USAF Force Protection: Is It Really Everyone's Responsibility?, prepared for Air War College, Air University, Maxwell AFB, Alabama, 9 December 2002, 16; United States Air Force, Air Force Handbook 10-222 Civil Engineer Guide to Expeditionary Force Protection, Vol 3, 1 May 2008, 12-13.

622 MSgt. Scott Melton, "Force Protection Through Engineering," The CE, Vol 7, No 1, Spring 1999, 26-27.

623 Joint Doctrine for Military Operations Other Than War, Joint Publication 3-07, 16 June 1995, I-1.

624 Ibid., vii, I-7.

625 Military Operations Other Than War, Air Force Doctrine Document 2-3, 3 July 2000, 12.

626 Fraser Cameron, US Foreign Policy After the Cold War: Global Hegemon or Reluctant Sheriff?, Routledge, Taylor & Francis Group, New York, second edition, 2005, 18, 20-22.

627 "RED HORSE: Hurricanes and Hope," USAFCE, Vol 1, No 6, August 1993, 8-9.

628 Ibid.; "RESTORE HOPE: The 823d Provides Help," USAFCE, Vol 1, No 1, February 1993, 23.

629 Capt. Efren V.M. Garcia, "RED HORSE Revets Mogadishu Airport," USAFCE, Vol 1, No 10, December 1993, 2-3.

630 Fraser Cameron, US Foreign Policy After the Cold War: Global Hegemon or Reluctant Sheriff?, Routledge, Taylor & Francis Group, New York, second edition, 2005, 18, 20-22.

631 Dr. Daniel L. Haulman, "Air Force Humanitarian Airlift Operations 1991-2000," 21 January 2010, accessed March 2011, www.afhra.af.mil/shared/media/document/AFD-100125-098.pdf.

632 Alan P. Dobson and Steve Marsh, US Foreign Policy Since 1945, Second Edition, Routledge Taylor & Francis Group, New York, 2006, 188-190.

633 Thomas R. Wilson, "Joint Intelligence and Uphold Democracy," Joint Force Quarterly, Spring 1995, 54-55, accessed March 2011, www.dtic.mil/doctrine/jel/jfq_pubs/jfq1407.pdf.

634 820th RED HORSE Squadron Deployment Summary, AHO; Capt. Nathan D. Broshear, "Airmen Rediscover RED HORSE Legacy in Haiti," 22 February 2010, accessed March 2011, www.

Chapter 6 Endnotes

1 Dr. Rebecca Grant, The War of 9/11, Air Force Association Special Report, February 2005, 1.
2 Maj. Gen. L. Dean Fox, "Farewell to the Troops," Air Force Civil Engineer [hereafter cited as AFCE], Vol 14, No 2, 2006, 2.
3 Maj. Gen. Eugene A. Lupia, (USAF, Retired), "Oral History Interview," Interview by Dr. Douglas H. Merkle and Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, 2002, Draft, 84-85.
4 Fraser Cameron, US Foreign Policy After the Cold War: Global Hegemon or Reluctant Sheriff?, Routledge, Taylor & Francis Group, New York and London, 2005, 137-139.
5 Ibid., 150-152.
6 Department of Defense, Quadrennial Defense Review, 30 September 2001, iii, 21, accessed May 2011, www.defense.gov/pubs/qdr2001.pdf.
7 Ibid., iii, iv, accessed May 2011, www.defense.gov/pubs/qdr2001.pdf.
8 Ibid., 13-16, accessed May 2011, www.defense.gov/pubs/qdr2001.pdf.
9 Ibid., 32, accessed May 2011, www.defense.gov/pubs/qdr2001.pdf.
10 Department of Defense, Quadrennial Defense Review, 6 February 2006, 1, accessed May 2011, www.defense.gov/qdr/report/report20060203.pdf.
11 Ibid., 19, accessed May 2011, www.defense.gov/qdr/report/report20060203.pdf.
12 MSgt. Mitch Gettle, "Air Force Releases New Mission Statement," Air Force Print News Today, 8 December 2005, accessed May 2011, www.af.mil/news/story_print.asp?id-123013440.
13 SSgt. C. Todd Lopez, "Air Force Improving Production with Smart Operations 21," Air Force Print News Today, 9 January 2006, accessed May 2011, www.af.mil/news/story_print.asp?id-123013978; SSgt. C. Todd Lopez, "Smart Operations 21 Office Formed at Pentagon," Air Force Print News Today, 9 January 2006, accessed May 2011, www.af.mil/news/story_print.asp?id-123020236.
14 The Air Force Smart Operations for the 21st Century CONOPS and Implementation Plan, Draft, 7 February 2006, accessed 2011, www.acc.af.mil/shared/media/document/AFD-070807-054.pdf; The Air Force Smart Operations for the 21st Century Playbook, May 2008, accessed 2011, www.au.af.mil/au/awc/awcgate/af/afd-090327-040_afso21-playbook.pdf.
15 ILE Annual History, Section VI, 2006, n.p.
16 Maj. Gen. L. Dean Fox, "Remaining the Best," AFCE, Vol 11, No 3, Fall 2003, 2.
17 Michael Culver, "Transforming the CE Enterprise," AFCE, Vol 15, No 5, 2007, 4.
18 Maj. Gen. Del Eulberg, "USAF: Enabling Air Force Priorities," The Military Engineer [hereafter cited as TME], Vol 101, No 659, May-June 2009, 85-87.
19 Dr. Ronald B. Hartzer, "Heritage to Horizons: Commemorating 60 Years of Air Force Civil Engineer History," AFCE, Vol 15, No 3, 2007, 23.
20 Maj. Gen. Del Eulberg, "Focus on Reconstruction," AFCE, Vol 17, No 1, 2009, 3.
21 "Brilliant at the Basics: Interview with Maj. Gen. Timothy A. Byers," AFCE, Vol 17, No 3, 2009, 4-9.
22 "Relevant, Right-sized, and Ready: An Interview with the Air Force Civil Engineer, Brig. Gen. Earnest O. Robbins II," The CE, Vol 7, No 3, Fall 1999, 4-9.
23 Maj. Gen. Earnest O. Robbins II, "Air Force Engineering: Global Vigilance, Reach, Power," TME, Vol 93, No 612, July-August 2001, 25-27.
24 ILE Annual History, 2004, n.p.; ILE Annual History, 2005, n.p.
25 "HQ Air Force A7C Divisions," AFCE Almanac, Vol 18, No 4, 2010, 8.
26 "Relevant, Right-sized, and Ready: An Interview with The Air Force Civil Engineer, Brig. Gen. Earnest O. Robbins II," The CE, Vol 7, No 3, Fall 1999, 4-9.
27 Maj. Gen. Earnest O. Robbins II, Statement to the House Armed Services Committee, 9 March 2000, Files of AFCEC History Office, Tyndall AFB, Florida [hereafter cited as AHO].
28 Maj. Gen. Earnest O. Robbins II, "Air Force Engineering: Global Vigilance, Reach, Power," TME, Vol 92, No 612, July-August 2001, 25-27.
29 Maj. Gen. Earnest O. Robbins II, "Air Force: Engineering Readiness," TME, Vol 94, No 618, July-August 2002, 30-31.
30 Maj. Gen. Earnest O. Robbins II, "Air Force Engineering: Global Vigilance, Reach, Power," TME, Vol 93, No 612, July-August 2001, 25-27.
31 Maj. Gen. Earnest O. Robbins II, "We're All on the Same Team," The CE, Vol 8, No 3, Fall 2000, 2.
32 Maj. Gen. Earnest O. Robbins II, "Air Force Engineering: Global Vigilance, Reach, Power," TME, Vol 93, No 612, July-August 2001, 25-27.
33 Maj. Gen. Earnest O. Robbins II, "Stay the Course," AFCE, Vol 9, No 3, Fall 2001, 2.
34 Ibid.
35 Maj. Gen. Earnest O. Robbins II, "Thank you and Farewell," AFCE, Vol 11, No 1, Spring 2003, 2
36 "Farewell Boss," AFCE, Vol 11, No 1, Spring 2003, 18.
37 Maj. Gen. Eugene A. Lupia was the first USAFA graduate to serve as The Civil Engineer. "Key CE Personnel Changes," AFCE, Vol 11, No 2, Summer 2003, 34.
38 Maj. Gen. L. Dean Fox, "A Rewarding Year," AFCE, Vol 12, No 2, 2004, 2.
39 "Putting People First: Interview with Maj. Gen. L. Dean Fox," AFCE, Vol 11, No 2, Summer 2003, 4-8.

40 Ibid.
41 Maj. Gen. L. Dean Fox, "Leading the Way into a New Year…," AFCE, Vol 13, No 4, 2005, 2.
42 Maj. Gen. L. Dean Fox, "Recognizing the Best," AFCE, Vol 14, No 1, 2006, 2.
43 Maj. Gen. L. Dean Fox, "Leading the Way into a New Year…," AFCE, Vol 13, No 4, 2005, 2.
44 "Fare Thee Well, Sir," AFCE, Vol 14, No 2, 2006, 18.
45 "Eulberg Named AF Civil Engineer," AFCE, Vol 14, No 1, 2006, 32.
46 "Farewell, General Eulberg," AFCE, Vol 17, No 2, 2009, 18-19.
47 "Listen, Learn and Lead: An Interview with Maj. Gen. Del Eulberg," AFCE, Vol 14, No 3, 2006, 4-9.
48 Ibid.
49 Maj. Gen. Del Eulberg, "Lessons Learned are Vital to our Capabilities," Vol 16, No 1, 2008, 3.
50 "Listen, Learn and Lead: An Interview with Maj. Gen. Del Eulberg," AFCE, Vol 14, No 3, 2006, 4-9.
51 Maj. Gen. Del Eulberg, "Leadership in Support of the Joint Warfighter," Vol 14, No 3, 2006, 2.
52 AFCE Almanac, Vol 15, No 4, 2007, 5.
53 Maj. Gen. Del Eulberg, "Final Salute," AFCE, Vol 17, No 2, 2009, 3.
54 "Brilliant at the Basics: Interview with Maj. Gen. Timothy A. Byers," AFCE, Vol 17, No 3, 2009, 4-9.
55 Ibid.
56 Ibid.
57 Teresa Hood, "Command Focus: Air Combat Command," AFCE, Vol 14, No 1, 2006, 4-5.
58 Department of Defense, Quadrennial Defense Review, 30 September 2001, 49-53, accessed May 2011, www.defense.gov/pubs/qdr2001.pdf.
59 Michael Culver, "Transforming the CE Enterprise," AFCE, Vol 15, No 5, 2007, 4-12.
60 Department of Defense, Quadrennial Defense Review, 30 September 2001, 25-27, accessed May 2011, www.defense.gov/pubs/qdr2001.pdf.
61 Ibid., 10, 47, 69, accessed May 2011, www.defense.gov/pubs/qdr2001.pdf.
62 Ibid., 49-53, accessed May 2011, www.defense.gov/pubs/qdr2001.pdf.
63 "Lean Management," Fact Sheet in 2004, IL Annual History, 2004.
64 ILE, Annual History, Section VI, 2005, n.p.
65 Michael Culver, "Transforming the CE Enterprise," AFCE, Vol 15, No 5, 2007, 4-12.
66 Ibid.
67 "Maximum Combat Support: An Interview with Brig. Gen. Del Eulberg," AFCE, Vol 11, No 4, Winter 2003, 4-7.
68 Lt. Col. Mike Hutchinson, "AMC Implements A7 Proposal," AFCE, Vol 11, No 4, Winter 2003, 8.
69 "Maximum Combat Support: An Interview with Brig. Gen. Del Eulberg," AFCE, Vol 11, No 4, Winter 2003, 4-7.
70 Ibid.
71 Ibid.
72 Lt. Col. Mike Hutchinson, "AMC Implements A7 Proposal," AFCE, Vol 11, No 4, Winter 2003, 8.
73 Teresa Hood, "Command Focus: Air Force Space Command," AFCE, Vol 13, No 2, 2005, 4; "Mission Support Directorate at HQ AFSPC," AFCE, Vol 11, No 3, Spring 2003, 33.
74 ILE Annual History, 2004, organizational charts.
75 Department of Defense News Release: Air Force Reorganizes Staff Structure, No 082-06, 30 January 2006, accessed May 2011, www.defense.gov/releases/release.aspz?releaseid=9268.
76 ILE Annual History, 20 October 2006, organizational chart.
77 Department of Defense News Release: Air Force Reorganizes Staff Structure, No 082-06, 30 January 2006, accessed May 2011, www.defense.gove/releases/release.aspz?releaseid=9268.
78 "HQ Air Force A7C Divisions," AFCE Almanac, Vol 15, No 4, 2007, 8.
79 Ibid.
80 Ibid., 8-9.
81 "HQ Air Force A7C Divisions," AFCE Almanac, Vol 18, No 4, 2010, 10.
82 Michael Culver, "Transforming the CE Enterprise," AFCE, Vol 15, No 5, 2007, 7-8.
83 AFCE Almanac, Vol 15, No 4, 2007, 13, 17, 25; AFCE Almanac, Vol 16, No 4, 2008, 13, 17, 25.
84 "New Deputy Civil Engineer on Board," AFCE, Vol 10, No 1, Spring 2002, 28
85 "Key Personnel Changes," AFCE, Vol 15, No 3, 2007, 34.
86 Biography, Mr. Mark A. Correll, AHO.
87 "Civil Engineering Gains New SES Position," AFCE, Vol 10, No 1, Spring 2002, 28.
88 "Key CE Personnel Changes," AFCE, Vol 10, No 2, Summer 2002, 33.
89 "Key Personnel Changes," AFCE, Vol 19, No 2, 2010, 35.
90 Gen. L. Dean Fox, "Leading the Way into a new Year…," AFCE, Vol 13, No 4, 2005, 2.
91 "Going to the Guard: Interview with Colonel Janice M. Stritzinger," AFCE, Vol 9, No 2, Summer, 2001, 4-5.
92 "Key Personnel Changes," AFCE, Vol 18, No 1, 2010, 41.
93 "Facing the Challenges: An Interview with James R. Pennino," AFCE, Vol 11, No 3, Fall, 2003, 4-7.
94 "Key Personnel Changes," AFCE, Vol 18, No 1, 2010, 41; Biography, Mr. Timothy K. Bridges, AHO.
95 Maj. Gen. Timothy A. Byers, "Building the Future," AFCE, Vol 17, No 4, 2009, 4; Maj. Robert C.

Lance, "Building Great Leaders by Keeping Young Officers," AFCE, Vol 18, No 2, 2010, 10-11.

96 Teresa Hood, "Former 'dirt boy' retires as Air Force's top enlisted Airman," AFCEC News Release, 28 January 2013.

97 Maj. Gen. Del Eulberg, "Transforming the CE Career Field," AFCE, Vol 15, No 1, 2007, 4-7.

98 Col. Doug Troyer, "Program Budget Decision 720, Force Shaping: Why Now?," Air Force Print News Today, 28 August 2007, accessed May 2011, www.vance.af.mil/news/story_print.asp?id=123066206; "PBD 720 and Force Shaping," Roll Call, 14 -21 December 1006, accessed May 2011, www.af.mil/shared/media/document/AFD-061218-013.pdf; Michael Culver, "Transforming the CE Enterprise," AFCE, Vol 15, No 5, 2007, 7.

99 Maj. Gen. Del Eulberg, "Transforming the CE Career Field," AFCE, Vol 15, No 1, 2007, 4-7.

100 "Force Shaping – Explaining the Numbers," Roll Call, 12-16 January 2007, accessed May 2011, www.af.mil/shared/media/document/AFD-070112-002.pdf; Josh Rogin, "Air Force to Reduce IT Personnel," Federal Computer Week, 21 August 2006, accessed May 2011, http://fcw.com/articles/2006/08/21/air-force-to-reduce-it-personnel.aspx.

101 Maj. Gen. L. Dean Fox, "USAF: At Home and Abroad," TME, Vol 98, No 641, May-June 2006, 83-85.

102 Michael Culver, "Transforming the CE Enterprise," AFCE, Vol 15, No 5, 2007, 7.

103 Maj. Gen. L. Dean Fox, "Farewell to the Troops," AFCE, Vol 14, No 2, 2006, 2.

104 "Force Shaping – Explaining the Numbers," Roll Call, 12-16 January 2007, accessed May 2011, www.af.mil/shared/media/document/AFD-070112-002.pdf.

105 Maj. Gen. Del Eulberg, "Transforming the CE Career Field," AFCE, Vol 15, No 1, 2007, 4-7.

106 Ibid.

107 Maj. Gen. Del Eulberg, "Transforming the CE Career Field," AFCE, Vol 15, No 1, 2007, 4-7; Implementation of Civil Engineer (CE) Transformation Plan, USAF, Program Action Directive 07-02, 19, April 2007, 3, IV-1-2.

108 Maj. Gen. Del Eulberg, "Transforming the CE Career Field," AFCE, Vol 15, No 1, 2007, 4-7; Michael Culver, "Transforming the CE Enterprise," AFCE, Vol 15, No 5, 2007, 7.

109 Implementation of Civil Engineer (CE) Transformation Plan, USAF, Program Action Directive 07-02, 19 April 2007, i.

110 Ibid., 1.

111 Ibid., 2.

112 Maj. Gen. Del Eulberg, "Transforming the CE Career Field," AFCE, Vol 15, No 1, 2007, 4-7.

113 Ibid.; Implementation of Civil Engineer (CE) Transformation Plan, USAF, Program Action Directive 07-02, 19 April 2007, 3, II-1-2; Concept of Operations For Fire Prevention and Consequence Management, USAF, 15 June 2007.

114 Maj. Gen. Del Eulberg, "Transforming the CE Career Field," AFCE, Vol 15, No 1, 2007, 4-7; Implementation of Civil Engineer (CE) Transformation Plan, USAF, Program Action Directive 07-02, 19 April 2007, 3, III-1-2.

115 Teresa Hood, "Re-Engineering AFMC," AFCE, Vol 15, No 2, 2007, 6-7.

116 CMSgt. Karl Deutsch, "RED HORSE: Saddled Up and Ready," AFCE, Vol 16, No 1, 2008, 14-15; SSgt. Drew Nystrom, "Air Force Beefs Up RED HORSE Capabilities," AFCE, Vol 16, No 3, 2008, 37; MSgt. Mike R. Smith, "A RED HORSE Rises in Ohio," AFCE, Vol 16, No 3, 2008, 38.

117 ILE, Annual History, Section VI, 2004, n.p.

118 ILE, Annual History, Section VI, 2005, n.p.

119 Ibid.

120 Maj. Christoff Gaub, "Business Process Reengineering," AFCE, Vol 15, No 5, 2007, 13.

121 Maj. Gen. Del Eulberg, "Transforming the CE Career Field," AFCE, Vol 15, No 1, 2007, 4-7.

122 Michael Culver, "Transforming the CE Enterprise," AFCE, Vol 15, No 5, 2007, 4-12; Maj. Gen. Del Eulberg, Transformation One Year Later, video briefing, May 2008.

123 See note above.

124 Michael Culver, "Transforming the CE Enterprise," AFCE, Vol 15, No 5, 2007, 4-12.

125 Maj. Gen. Del Eulerg, "Asset Management," AFCE, Vol 15, No 2, 2007, 2.

126 Ibid.

127 USAF Memorandum from AF/A7C, Subject: Civil Engineer (CE) Transformation Governance, 25 July 2007.

128 Michael Culver, "Transforming the CE Enterprise," AFCE, Vol 15, No 5, 2007, 4-12; Maj. Christopher Gaub, "Business Process Reengineering," AFCE, Vol 15, No 5, 2007, 13.

129 Maj. Gen. Del Eulberg, Transformation One Year Later, video briefing, May 2008.

130 Maj. Gen. Timothy A. Byers, "Connecting the Transformation Dots," Air Force Civil Engineer, Vol 18, No 1, 2010, 9-11.

131 HQ USAF, Program Action Directive 12-03, "Implementation of Enterprise-Wide Civil Engineer Transformation," 26 October 2012, 8-9.

132 Michael Culver, "Transforming the CE Enterprise," AFCE, Vol 15, No 5, 2007, 4-12.

133 Maj. Gen. Del Eulberg, Transformation One Year Later, video briefing, May 2008.

134 Ibid., "Final Salute," AFCE, Vol 17, No 2, 2009, 3.

135 Michael Culver, "Transforming the CE Enterprise," AFCE, Vol 15, No 5, 2007, 4-12; Maj. Gen. Del

Eulberg, "Managing Air Force Assets," Air Force Civil Engineer, Vol 16, No 1, 2008. 5.

136 ILE, Annual History, Section VI.i., 2004, n.p.

137 Maj. Gen. Del Eulberg, "Transforming the Way We Work," AFCE, Vol 15, No 5, 2007, 2.

138 ILE, Annual History 2004, Section VI.ac, n.p.

139 ILE, Annual History 2005, Section VI, n.p.

140 Maj. Gen. Del Eulberg, "Strategic Planning: Keeping us Focused," AFCE, Vol 16, No 2, 2009, 3.

141 Maj. Gen. Del Eulberg, "Focus on Reconstruction," AFCE, Vol 17, No 1, 2009, 3.

142 Maj. Gen. Del Eulberg, "Final Salute," AFCE, Vol 17, No 2, 2009, 3.

143 "Brilliant at the Basics: Interview with Maj. Gen. Timothy A. Byers," AFCE, Vol 17, No 3, 2009, 4-9.

144 Maj. Gen. Timothy Byers, "Air Force Civil Engineering: Efficiencies through Sustainability," TME, Vol 103, No 671, 98-100.

145 Lois E. Walker, History of the Air Force Civil Engineer Support Agency (RCS: HAF-HO[A]7101), 1 January – 31 December 2001, Vol I, Chronology, 12.

146 Ibid., 11.

147 Col. Richard A. Fryer, Jr., "AFCESA," AFCE, Vol 15, No 3, 2007, 31.

148 MSgt. Michael A. Ward, "$19 Billion AFCAP Award," AFCE, Vol 13, No 4, 2005, 30.

149 Brian Poyant, "Connecting the CE Community," AFCE, Vol 13, No 2, 2005, 33.

150 "A-Grams Go Electronic," AFCE, Vol 10, No 2, Summer 2002, 32.

151 Brian Poyant, "Connecting the CE Community," AFCE, Vol 13, No 2, 2005, 33.

152 Sandra Scott, "Call a CoP!," AFCE, Vol 16, No 2, 2008, 30.

153 AFCESA Reach Back Center, AFCESA A-Gram 05-08, June 2005, AHO

154 Brian Poyant, "Connecting the CE Community," AFCE, Vol 13, No 2, 2005, 33; AFCESA Reach Back Center, AFCESA A-Gram 05-08, June 2005, AHO.

155 Capt. Chrissy Cuttita, "Moving Forward by Reaching Back," AFCE, Vol 15, No 3, 2007, 36.

156 "SRM Moving to New Home," AFCE, Vol 12, No 2, 2004, 32.

157 Sustainment, Restoration and Modernization (S/R&M), Air Force Fact Sheet, accessed May 2011, www.afcesa.af.mil/library/factsheets/factsheet_print.asp?fsID=8952&page=1.

158 Capt. Chrissy Cuttita, "S/R&M: A Complete Solution," AFCE, Vol 14, No 2, 2006, 12-13.

159 "SATOC Contract Award Announced," AFCE, Vol 16, No 1, 2008, 29.

160 "AFCESA," AFCE Almanac, Vol 15, No 4, 2007, 34-35.

161 "AFCESA,"AFCE Almanac, Vol 17, No 4, 2009, 34-35.

162 AFCESA, Fact sheet, February 2007, accessed January 2010, www.af.mil/information/factsheets/factsheet.asp?id=140.

163 CenterViews, Vol 12, No 3, Fall 2006, 2.

164 "AFCESA," AFCE Almanac, Vol 15, No 4, 2007, 34-35; "AFCESA," AFCE Almanac, Vol 16, No 4, 2008, 34-35; "AFCESA," AFCE Almanac, Vol 17, No 4, 2009, 34-35; "AFCESA," AFCE Almanac, Vol 18, No 4, 2010, 35-36.

165 Capt. Chrissy Cuttita, "Moving Forward by Reaching Back," AFCE, Vol 15, No 3, 2007, 36; MSgt. Darius Johnson, "Learning from Your Experiences," AFCE, Vol 16, No 1, 2008, 8-9; Maj. Gen. Del Eulberg, "Lessons Learned Are Vital to Our Capabilities," AFCE, Vol 16, No 1, 2008, 3.

166 Pat Mumme, "Going Green: AFCESA Facility Energy Program," AFCE, Vol 12, No 2, 2004, 8-9; Col. Richard Fryer, Jr., "AFCESA," AFCE, Vol 15, No 2, 2007, 33.

167 Bullet Background Paper on Air Force Facility Energy Program History, AHO; Maj. Gen. Del Eulberg, "Meeting our Energy Challenges," AFCE, Vol 16, No 3, 2008, 4.

168 Maj. Gen. Del Eulberg, "Meeting Our Energy Challenges," AFCE, Vol 16, No 3, 2008, 4.

169 "AFCESA," AFCE Almanac, Vol 15, No 4, 2007, 34-35.

170 Air Force Civil Engineer Support Agency, brochure, 2010-2011, 20 pages.

171 Ibid.

172 MSgt. Mike Chapman, "Ensuring a Safe Landing," AFCE, Vol 13, No 3, 2005, 12.

173 Lois E. Walker, History of the Air Force Civil Engineer Support Agency (RCS: HAF-HO[A]7101), 1 January – 31 December 2001, Vol I, Chronology.

174 Ibid.

175 TSgt. Michael A. Ward, "Pavements Team Brings Expertise to the Flight," AFCE, Vol 9, No 4, 2001, 9.

176 2d Lt. Joseph Wierenga, "From Rubble to Runway," AFCE, Vol 14, No 1, 2006, 8-10.

177 Peter M. Semen, Charles J. Korhonen, Raymond S. Rollings, U.S. Army ERDC, "We've Got it Down Cold," AFCE, Vol 12, No 4, 2004, 29.

178 2d Lt. Joseph Wierenga, "From Rubble to Runway," AFCE, Vol 14, No 1, 2006, 8-10.

179 Col. Mark Ruse and Mark Dent, "Dover's Runway Undergoes 'Reconstructive Surgery,'" AFCE, Vol 17, No 3, 2009, 22-23.

180 R. Craig Mellerski and Craig A. Rutland, "The New Face of Rapid Airfield Repair," AFCE, Vol 17, No 3, 2009, 26.

181 Jere L. Brinkley and 1st Lt. Andrew Kopeikin, "Future of Airfield Damage Assessment," AFCE, Vol 18, No 1, 2010, 33.

182 R. Craig Mellerski and Craig A. Rutland, "The New Face of Rapid Airfield Repair," AFCE, Vol 17, No 3, 2009, 27.

183 Lois E. Walker, History of the Air Force Civil Engineer Support Agency (RCS: HAF-HO[A]7101), 1 January – 31 December 2001, Input HQ AFECSA/CEM, Field Support Directorate.

184 Lois E. Walker, History of the Air Force Civil Engineer Support Agency (RCS: HAF-HO[A]7101), 1 January – 31 December 2001, Vol I, Chronology.

185 CMSgt. Glenn Deese, "Securing a Safe Landing," AFCE, Vol 11, No 2, Spring 2003, 28.

186 Ibid., 29.

187 Dan Nash, "Doing More With Less," AFCE, Vol 13, No 1, 2005, 22.

188 Lois E. Walker, History of the Air Force Civil Engineer Support Agency (RCS: HAF-HO[A]7101), 1 January – 31 December 2001, Vol I, Appendix H, n. p.

189 Ibid., Chronology, 1, 2, 12.

190 Ibid., Appendix H, n. p.

191 Ibid.

192 Joseph H. Smith, "Retirement Interview," Interview by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, 2004, 53.

193 Maj. Gen. Earnest O. Robbins II, "Air Force Civil Engineers – Serving Proudly," AFCE, Vol 9, No 4, Winter 2001, 2.

194 Lois E. Walker, History of the Air Force Civil Engineer Support Agency (RCS: HAF-HO[A]7101), 1 January – 31 December 2001, Vol I, Appendix H, n. p.

195 Joseph H. Smith, "Retirement Interview," Interview by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, 2004, 54.

196 "Air Force Contract Augmentation Program (AFCAP)," accessed May 2011, www.globalsecurity.org/military/agency/usaf/afcap.htm; Joseph H. Smith, "Retirement Interview," Interview by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, 2004, 58-59.

197 "Air Force Augmentation Program," SourceWatch, 2006, accessed May 2011, www.sourcewatch.org/index.php?title=Air_Force_Augmentation_Program.

198 "Air Force Contract Augmentation Program (AFCAP)," accessed May 2011, www.globalsecurity.org/military/agency/usaf/afcap.htm.

199 "A Stealth Beddown," AFCE, Vol 11, No 1, Spring 2003, 9; "Help Arrives from CEMIRT, AFCAP," AFCE, Vol 11, No 1, Spring 2003, 10.

200 "CE Goes to War," AFCE, Vol 11, No 1, Spring 2003, 4; "Help Arrives from CEMIRT, AFCAP," AFCE, Vol 11, No 1, Spring 2003, 10.

201 Joseph H. Smith, "Retirement Interview," Interview by Lois E. Walker, HQ AFCESA, Tyndall AFB, Florida, 2004, 58-59.

202 "Air Force Contract Augmentation Program (AFCAP)," accessed May 2011, www.globalsecurity.org/military/agency/usaf/afcap.htm.

203 Maj. Gen. L. Dean Fox, "Supporting Airmen Throughout the World," TME, May-June 2005, Vol 97, No 635, n.p.

204 MSgt. Michael A. Ward, "$10 Billion AFCAP Award," AFCE, Vol 13, No 4, 2005, 30.

205 "$10B AFCAP III Program Contract Provides 'Expeditionary Engineering'," Defense Industry Daily (DID), 10 November 2005, accessed May 2011, www.defenseindustrydaily.com/10b-afcap-iii-program-contract-provides-expeditionary-engineering-01468.

206 MSgt. Michael A. Ward, "$19 Billion AFCAP Award," AFCE, Vol 13, No 4, 2005, 30.

207 Wayland Patterson, "AFCAP Begins a New Decade," AFCE, Vol 15, No 3, 2007, 8-10.

208 Ibid.

209 "AFCEE Director Earns Presidential Honor," AFCE, Vol 10, No 1, Spring 2002, 30.

210 Gil Dominguez, "Reorganization Continues Legacy," CenterViews, Vol 10, No 1 Spring 2004, 6.

211 Implementation of Civil Engineer (CE) Transformation Plan, USAF, Program Action Directive 07-02, 19 April 2007, I-4.

212 Paul A. Parker, "No Rest for the Center of Excellence," CenterViews, Vol 10, No 4, Winter 2004/2005, 3.

213 Ibid., "The Technical Directorate: AFCEE's 'Brain Trust'," CenterViews, Vol 11, No 5, Winter 2005/2006, 3.

214 Gil Dominguez, "Reorganization Continues Legacy," CenterViews, Vol 10, No 1, Spring 2004, 6-7.

215 Ibid., 7.

216 AFCEE's Iraq Reconstruction Chronology, 2007, AHO.

217 Gil Dominguez, "AFCEE Helping in Rebuilding Iraq," CenterViews, Vol 10, No 2, Summer 2004, 6-10; Gil Dominguez, "IRAQ Contracting gets Top Attention," CenterViews, Vol 10, No 2, Summer 2004, 11-12.

218 Maj. Gen. Del Eulberg, "Building Partnerships Through Reconstruction," AFCE, Vol 17, No 1, 2009, 4-6; WERC Chronology, 2007 AHO.

219 Gil Dominguez, "IRAQ Contracting gets Top Attention," CenterViews, Vol 10, No 2, Summer 2004, 11-12.

220 WERC Chronology, 2007, AHO.

221 Ibid.
222 Gil Dominguez, “AFCEE Helping in Rebuilding Iraq,” CenterViews, Vol 10, No 2, Summer 2004, 8-9; Paul Parker, “View from the Center,” CenterViews, Vol 11, No 1, Spring 2005, 3.
223 Maj. Gen. Del Eulberg, “Building Partnerships Through Reconstruction,” AFCE, Vol 17, No 1, 2009, 4-6.
224 Lt. Gen. David Petraeus, MNSTC-I, E-mail to Lt. Gen. Donald Wetekam, HQ USAF/IL “AFCEE Contract Support in Iraq,” 18 September 2004.
225 Paul Parker, “View from the Center,” CenterViews, Vol 11, No 1, Spring 2005, 3.
226 Maj. Gen. Del Eulberg, “Building Partnerships Through Reconstruction,” AFCE, Vol 17, No 1, 2009, 4-6.
227 “Work at Al Kasik In Final Stages,” CenterViews, Vol 11, No 1, Summer 2005, 6-8.
228 Gil Dominguez, “Iraq Contracting gets Top Attention,” CenterViews, Vol 10, No 2, Summer 2004, 11-12.
229 “Work at Al Kasik In Final Stages,” CenterViews, Vol 11, No 1, Summer 2005, 6-8.
230 Maj. Gen. Del Eulberg, “Building Partnerships Through Reconstruction,” AFCE, Vol 17, No 1, 2009, 4-6.
231 Gil Dominguez, “IRAQ Contracting gets Top Attention,” CenterViews, Vol 10, No 2, Summer 2004, 11-12.
232 Maj. Gen. Del Eulberg, “Building Partnerships Through Reconstruction,” AFCE, Vol 17, No 1, 2009, 4-6.
233 Paul Parker, “View from the Center,” CenterViews, Vol 11, No 1, Spring 2005; Maj. Gen. L. Dean Fox, “Supporting Airmen Throughout the World,” TME, May-June 2005, Vol 97, No 635, n.p.
234 Marti D. Ribeiro, “Wells to Provide Water to Iraq Border Forts,” CenterViews, Vol 13, No 2, Summer 2007, 13.
235 Paul Parker, “AFCEE,” AFCE, Vol 15, No 3, 2007, 31.
236 SSS to CSAF, Subject: AFCEE’s exit strategy from Iraq, 24 August 2005, WERC Chronology, 2007, AHO.
237 Paul Parker, “AFCEE,” AFCE, Vol 15, No 3, 2007, 31.
238 Maj. Gen. Del Eulberg, “Building Partnerships Through Reconstruction,” AFCE, Vol 17, No 1, 2009, 4-6.
239 Elaine Eliah, “Calling All Contractors: AFCEE Meets with Companies Doing Work in Iraq,” Center-Views, Vol 12, No 3, Fall 2006, 15-16.
240 Maj. Gen. Del Eulberg, “Building Partnerships Through Reconstruction,” AFCE, Vol 17, No 1, 2009, 4-6.
241 “Change, Achievement Mark 2007,” CenterViews, Vol 13, No 4, Winter 2007, 5.
242 Gil Dominguez, “Increased Business, Iraq Work Mark 2004,” CenterViews, Vol 10, No 4, Winter 2004/2005, 4-6.
243 Ibid.
244 “Center Announces Award of $6 Billion Contract Package,” CenterViews, Vol 12, No 1, Spring 2006, 21.
245 “Small Business Gets Share of HERC Contracts, CenterViews, Vol 12, No 2, Summer 2006, 10.
246 US Air Force Family Housing Guide for Planning, Programming, Design, and Construction, 5-6, August 2004, Files of the AFCESA History Office, Tyndall AFB, Florida.
247 Gil Dominguez, “Increased Business, Iraq Work Mark 2004,” CenterViews, Vol 10, No 4, Winter 2004/2005, 4-6.
248 “No Shortage of Big Stories in 2006,” CenterViews, Vol 12, No 4, Winter 2006/2007, 26-27; “New Keesler AFB Housing is Warm and Inviting,” 10 March 2010, WLOX-ABC-Channel 13, accessed May 2012, www.wlox.com/story/12118497/new-keesler-afb-housing-is-warm-and inviting.
249 “Keelser’s First Energy, Environmental-Friendly Home Certified,” Air Force Print News, 8/28/2008, accessed May 2012, www.af.mil/news/story_print.asp?id=123112477; “AFCEE,” AFCE Almanac, Vol 18, No 4, 2010, 34.
250 “Housing Privatization Continues to Achieve Milestones,” Air Force Print News, 10/20/2010, accessed May 2012, www.afcee.af.mil/news/story_print.asp?id=123227169.
251 Gen. John P. Jumper, “Memorandum: Military Family Housing (MHF) Privatization – Rescission of Severability Policy,” Department of the Air Force Office of the Chief of Staff, September 2003, AHO.
252 SSgt. C. Todd Lopez, “Air Force Reaches Privatization Milestone,” AFCE, Vol 13, No 2, 2005, 26.
253 Maj. Gen. Earnest O. Robbins II, “Air Force Engineering: Global Vigilance, Reach, Power,” TME, Vol 93, No 612, July-August 2001, 27.
254 “Robins, Dyess Celebrate 10 Years of Housing Privatization,” 20 October 2010, Air Force Center for Engineering and the Environment, accessed May 2012, www.afcee.af.mil/news/story.asp?id=123227162; SSgt. C. Todd Lopez, “Air Force Reaches Privatization Milestone,” AFCE, Vol 13, No 2, 2005, 26.
255 “AFCEE Marks 15th Anniversary,” CenterViews, Vol 12, No 2, Summer 2006, 13.
256 Maj. Bo Bloomer, “Military Housing Still Safe and Secure,” AFCE, Vol 14, No 2, 2006, 4-6.
257 “AFCEE,” AFCE Almanac, Vol 15, No 4, 2007, 32.

258 "AFCEE," AFCE Almanac, Vol 18, No 4, 2010, 34.

259 "Housing Privatization Continues to Achieve Milestones," Air Force Print News, 10/20/2010, accessed May 2012, www.afcee.mil/news/story_print.asp?id=123227169.

260 "AFCEE," AFCE Almanac, Vol 19, No 4, 2010, 37; "Keelser Housing Privatization Begins Transition in August," Air Force Print News, 6/29/2011, accessed May 2012, www.keesler.af.mil/news/story_print.asp?id=123262133.

261 Lisa Fisher, "Housing Privatization Program Continues to Achieve Milestones," CenterViews, Vol 17, No 1, January-March 2011, 13-14.

262 "Keelser's First Energy, Environmental-Friendly Home Certified," Air Force Print News, 8/28/2008, accessed May 2012, www.af.mil/news/story_print.asp?id=123112477.

263 Paula Shaw and Tim Adams, "Sustainable Facilities: An Air Force Tradition," AFCE, Vol 16, No 3, 2008, 12.

264 Maj. Gen. Del Eulberg, "Meeting Our Energy Challenges, AFCE, Vol 16, No 3, 2008, 4.

265 Gil Dominguez, "Thirty Years of Design Excellence," CenterViews, Vol 11, No 3, Fall 2004, 4-7.

266 "Environmental Work Still Tops at AFCEE," CenterViews, Vol 10, No 4, Winter 2004/2005, 6-8.

267 Ibid.

268 Maj. Gen. L. Dean Fox, "Continuing the Mission," AFCE, Vol 12, No 3, 2004, 2.

269 "RPO Helps Get 'More Bang for the Buck'," CenterViews, Vol 10, No 4, Winter 2004/2005, 16-17.

270 Ibid.

271 Roger Williams, "Using the Best Approach," AFCE, Vol 13, No 3, 2005, 14-15.

272 "First-of-its-kind Approach at MacDill," CenterViews, Vol 13, No 1, Spring 2007, 22-23.

273 "Air Force Bids Goodbye to Old System, CenterViews, Vol 10, No 2, Summer 2004, 25.

274 "REOs Serve as Air Force 'Eyes and Ears'," CenterViews, Vol 10, No 3, Fall 2004, 8-9.

275 "PROACT Provides the Answers to Environmental Questions," CenterViews, Vol 10, No 2, Summer 2004, 26.

276 Jennifer Schneider, "When PRO-ACT was the ANSR," CenterViews, Vol 17, No 3, July-September 2011, 20.

277 Gil Dominiguez, "Give Me A 'W': WEB University 'Campus' Thriving," CenterViews, Vol 11, No 2, Summer 2005, 18.

278 Gil Dominguez, "AFCEE Looking for 'Leaner' Way To Do Business," CenterViews, Vol 11, No 3, Fall 2005, 10-11.

279 "No Shortage of Big Stories in 2006," CenterViews, Vol 12, No 4, Winter 2006/2007, 26-27.

280 Implementation of Civil Engineer (CE) Transformation Plan, USAF, Program Action Directive 07-02, 19 April 2007, 2; Paul A. Parker, "The Air Force Center For Environmental Excellence is No More," CenterViews, Vol 13, No 1, Spring 2007, 4.

281 Maj. Gen. Del Eulberg, "Transforming the CE Career Field," AFCE, Vol 15, No 1, 2007, 4-7.

282 Implementation of Civil Engineer (CE) Transformation Plan, USAF, Program Action Directive 07-02, 19 April 2007, I-2; Maj. Gen. Del Eulberg, "USAF: Engineering for the Future," TME, Vol 100, No 653, May-June 2008, 77-79.

283 Implementation of Civil Engineer (CE) Transformation Plan, USAF, Program Action Directive 07-02, 19 April 2007, I-5.

284 Gil Dominiguez, "Air Force Transformation Changing AFCEE," CenterViews, Vol 12, No 4, Winter 2006/2007, 5-6.

285 Implementation of Civil Engineer (CE) Transformation Plan, USAF, Program Action Directive 07-02, 19 April 2007, I-2; Maj. Gen. Del Eulberg, USAF: Engineering for the Future, TME, Vol 100, No 653, May-June 2008, 77-79; Gil Dominiguez, "Air Force Transformation Changing AFCEE," CenterViews, Vol 12, No 4, Winter 2006/2007, 5.

286 See note above.

287 "AFCEE Combines Housing and Military Construction Missions," CenterViews, Vol 13, No 4, Winter 2007, 6.

288 "AFCEE," AFCE Almanac, Vol 15, No 4, 2007, 32.

289 "AFCEE," AFCE Almanac, Vol 17, No 4, 2009, 32.

290 "AFCEE," AFCE Almanac, Vol 15, No 4, 2007, 32; "AFCEE," AFCE Almanac, Vol 18, No 4, 2010, 34.

291 Paul A. Parker, "The Air Force Center For Environmental Excellence is No More," CenterViews, Vol 13, No 1, Spring 2007, 4.

292 "Key Personnel," AFCE, Vol 16, No 1, 2008, 32; "Mr. Dennis Firman Retires," AFCE, Vol 18, No 3, 2010, 33.

293 "Key Personnel Updates," AFCE, Vol 18, No 4, 47.

294 Air Force Center for Engineering and the Environment, HQ, Organizational details – actions, printout from Air Force Historical Research Agency, Maxwell AFB, Alabama; Air Force Center for Engineering and the Environment, accessed May 2011, www.afcee.af.mil/about/organizationalchart/index.asp.

295 Organizational Chart, AF Center for Engineering and the Environment, accessed May 2011, www.afcee.af.mil/about/organizationalchart/index.asp.

296 Lineage and Honors Fact Sheet, "Air Force Real Property Agency (USAF), 2010, AHO; "AFRPA," AFCE Almanac, Vol 15, No 4, 2007, 36.

297 Air Force Real Property Agency, accessed March 2011, www.af.mil.information/factsheets.

298 Linda Geissinger, "Challenging and Changing," AFCE, Vol 13, No 2, 2005.

299 Ibid.

300 USAF HQ USAF/ILE, Memorandum to All Major Command Headquarters, Subject: New Enhanced-Use Leasing Policy, signed by Michael A. Aimone, The Deputy Civil Engineer, DCS/Installations & Logistics, 14 June 2000.

301 Office of the Secretary of Defense, Memorandum to Secretaries of the Military Departments, Chairman of the Joint Chiefs of Staff under Secretaries of Defense, etc., Subject: Section 2667 of Title 10, United States Code: Enhanced-Use Leasing, signed by Randall A. Yim, Deputy Under Secretary (Installations), 10 May 2011.

302 USAF SAF/IEI, Memorandum to AF/ILE, Subject: Enhanced Use Leasing Initiatives, signed by W. Kuhn, Deputy Assistant of the Air Force (Installations), 14 April 2003.

303 Teresa Hood, "Command Focus: Air Force Materiel Command," AFCE, Vol 15, No 2, 2007, 4-5; Linda Geissinger, "Recouping Value with EULs," AFCE, Vol 16, No 2, 2008, 18-19.

304 "AFRPA," AFCE Almanac, Vol 15, No 4, 2007, 36-37.

305 Ibid.

306 2005 Defense Base Closure and Realignment Commission Report, 2005, 223-224, accessed May 2011, www.brac.gov/finalreport.html.

307 "AFRPA," AFCE Almanac, Vol 16, No 4, 2008, 36-37.

308 Ibid.

309 Linda Geissinger, "Recouping Value with EULs," AFCE, Vol 16, No 2, 2008, 18-19.

310 Teresa Hood, "Let's Make a Deal," AFCE, Vol 13, No 2, 2005, 5-8.

311 Linda Geissinger, "Recouping Value with EULs," AFCE, Vol 16, No 2, 2008, 18-19.

312 "AFRPA," AFCE Almanac, Vol 17, No 4, 2009, 36-37.

313 Ibid.

314 Ibid.; Armando Perez, "Enhanced Use Lease Projects Break Ground in Utah and Nevada," AFCE, Vol 17, No 1, 2009, 32.

315 "AFRPA," AFCE Almanac, Vol 17, No 4, 2009, 36-37.

316 "AFRPA," AFCE Almanac, Vol 18, No 4, 2010, 38-39.

317 Air Force Real Property Agency, Fact Sheet, accessed March 2011, www.af.mil.information/factsheets.

318 "Going to the Guard: Interview with Col. Janice M. Stritzinger," AFCE, Vol 9, No 2, Summer 2001, 4.

319 TSgt. Michael A. Ward, "A Tale of Two Squadrons," AFCE, Vol 10, No 1, Spring 2002, 27; Maj. William K. Giezie, "Taking the Reins," AFCE, Vol 11, No 2, Summer 2003, 23.

320 "Putting People First: Interview with Maj. Gen. L. Dean Fox," AFCE, Vol 11, No 2, Summer 2003, 4-8.

321 "C-23 crashes in Georgia, 21 dead," St. Augustine, Florida (AFPN), 4 March 2001, AHO; Maj. Debbie Magaldi, "203rd RED HORSE Dedicates Memorial to Fallen Airmen," Virginia National Guard, 14 March 2002, accessed April 2011, http://vko.va.ngb.army.mil.

322 Maj. Debbie Magaldi, "203rd RED HORSE Dedicates Memorial to Fallen Airmen," Virginia National Guard, 14 March 2002, accessed April 2011, http://vko.va.ngb.army.mil; "Memorial to Honor Fallen Horsemen," AFCE, Vol 9, No 2, Summer 2001, 31.

323 Maj. Debbie Magaldi, "203rd RED HORSE Dedicates Memorial to Fallen Airmen," Virginia National Guard, 14 March 2002, accessed April 2011, http://vko.va.ngb.army.mil; Cotton Puryear, "203rd RED HORSE Holds Memorial Service for Airmen, Soldiers Lost in Airplane Crash 10 Years Ago," 4 March 2011, accessed April 2011, http://vko.va.ngb.army.mil/VirginiaGuard/news/mar11/203rdmemorial.html

324 Lt. Col. Gerald A. Buckman, Sr., "Making the Future Total Force Work," U.S. Army War College Strategy Research Project, U.S. Army War College, Carlisle Barracks, Pennsylvania, 2006, 2, accessed May 2011.

325 John A. Tirpak, "Integrated Total Force," Air Force Magazine, Vol 91, No 3, March 2008, 24.

326 Maj. Gen. Del Eulberg, Air Force Civil Engineer's Commanders Call, video script, August 2007, n.p.

327 Maj. Gen. Del Eulberg, "IT Transformation," AFCE, Vol 16, No 2, 2008, 4-7.

328 Maj. Gen. L. Dean Fox, "Back to the Bases," AFCE, Vol 11, No 2, Spring 2003, 2.

329 "Putting People First: Interview with The Air Force Civil Engineer, Maj. Gen. L. Dean Fox," AFCE, Vol 11, No 2, Spring 2003, 4-5.

330 Maj. Gen. L. Dean Fox, "Remaining the Best!," AFCE, Vol 11, No 3, Fall 2003, 2.

331 "Back-to-Bases Task Force Final Report," November 2003, Background and Introduction, AHO; Maj. Gen. L. Dean Fox, "Remaining the Best!," AFCE, Vol 11, No 3, Fall 2003, 2.

332 "Back-to-Bases Task Force Final Report," November 2003, AHO; Maj. Gen. L. Dean Fox, "Happy New Year!," AFCE, Vol 11, No 4, Winter 2003, 2.

333 Maj. Gen. L. Dean Fox, "A Winning Season!" AFCE, Vol 12, No 1, Spring 2004, 2.

334 Maj. Gen. L. Dean Fox, "Transitions," AFCE, Vol 13, No 3, 2005, 2.

335 Maj. Gregory J. Rosenmerkel, "PACAF Programs Cover All Bases," AFCE, Vol 11, No 4, Winter 2003,

16.

336 Ibid., 17.

337 William L. Luthie, "A New Twist on an Old Concept," AFCE, Vol 11, No 1, Spring 2003, 24.

338 Civil Engineer Squadron Reorganization Implementation Plan, Program Action Directive 07-02, Implementation of the Civil Engineer (CE) Transformation Plan, HQ AFCESA, USAF, 15 November 2007, 9-11.

339 Ibid.

340 Ibid., 3.

341 Ibid., 2-3.

342 Maj. Gen. Del Eulberg, Transformation One Year Later, video briefing, May 2008.

343 Engineer Squadron Reorganization Implementation Plan, Program Action Directive 07-02, Implementation of the Civil Engineer (CE) Transformation Plan, HQ AFCESA, USAF, 15 November 2007, 3.

344 Ibid., 12-13.

345 Ibid., 12.

346 Lt. Col. Wade Lawrence, "Shifting to an Asset Management Culture," AFCE, Vol 15, No 5, 2007, 14.

347 Activity Management Planning (AMP) Handbook, Managing CE Service Delivery, 2 March 2011, 7.

348 Lt. Col. Mark Madaus, "AMP Implementation Update," AFCE, Vol 17, No 2, 2009, 7.

349 A7C Annual History, 2009, Section VI, n.p.

350 Activity Management Planning (AMP) Handbook, Managing CE Service Delivery, 2 March 2011, 7.

351 Lt. Col. Mark Madaus, "AMP Implementation Update," AFCE, Vol 17, No 2, 2009, 7.

352 A7C Annual History, 2009, Section VI, n.p.; A7C Annual History, 2010, Section VI, n.p

353 Maj. Gen. Timothy A. Byers, "Connecting the Transformation Dots," AFCE, Vol 18, No 1, 2010, 9-11.

354 Geri Hart, "'Room' to Improve: New Possibilities Through Space Optimization," AFCE, Vol 17, No 2, 2009, 8-9.

355 Ibid.

356 Maj. Gen. Timothy A. Byers, "Air Force Engineers: Building to Last and Leading Change," TME, Vol 102, No 665, May-June, 2010, 91-93.

357 A7C Annual History, 2009, Section VI, n.p.

358 A7C Annual History, 2010, Section VI, n.p.

359 Maj. Gen. Timothy A. Byers, "S-File Key to 20/20 by 2020 Success," AFCE, Vol 18, No 3, 2010, 4-5.

360 Ibid.

361 "Air Force Demolition Policy, HQ USAF White Paper, March 2009," AHO; Waltrina Davis, "Demolition of Excess Facilities," AFCE, Vol 17, No 2, 2009, 10.

362 "Air Force Demolition Policy, HQ USAF White Paper, March 2009," 2, Files of AFCESA History Office; Maj. Gen. Del Eulberg, Transformation One Year Later, video briefing, May 2008; Maj. Gen. Del Eulberg, "USAF: Enabling Air Force Priorities," TME, Vol 101, No 659, May-June 2009, 85-87; Maj. Gen. Timothy A. Byers, "S-File Key to 20/20 by 2020 Success," AFCE, Vol 18, No 3, 2010, 4-5.

363 Waltrina Davis, "Demolition of Excess Facilities," AFCE, Vol 17, No 2, 2009, 10.

364 Maj. Gen. Del Eulberg, Transformation One Year Later, video briefing, May 2008; Maj. Gen. Del Eulberg, "USAF: Enabling Air Force Priorities," TME, Vol 101, No 659, May-June 2009, 85-87; Maj. Gen. Timothy A. Byers, "S-File Key to 20/20 by 2020 Success," AFCE, Vol 18, No 3, 2010, 4-5.

365 Maj. Gen. Timothy A. Byers, "S-File Key to 20/20 by 2020 Success," AFCE, Vol 18, No 3, 2010, 4-5.

366 Maj. Gen. Del Eulberg, "Transforming the CE Career Field," AFCE, Vol 15, No 1, 2007, 4-7; Implementation of Civil Engineer (CE) Transformation Plan, USAF, Program Action Directive 07-02, 19 April 2007, 3, II-1-2; Concept of Operations For Fire Prevention and Consequence Management, USAF, 15 June 2007.

367 Maj. Gen. Del Eulberg, "Transforming Air Force Firefighting," AFCE, Vol 15, No 3, 2007, 5.

368 A1C. Erica Stewart, "VAFB Hot Shots Crew Helps Battle Blaze," Air Force News, 3 October 2006, accessed 27 May 2011, www.vandenberg.af.mil/news/story.asp?id=123029208.

369 E-mail, Floyd A. Jones, Dep Fire Chief, Dyess AFB, TX to Dr. Ronald B. Hartzer, 3 Dec 2013; USC Title 10 Section 2465, "Prohibition on contracts for performance of firefighting or security-guard functions."

370 TSgt. Rey Ramon, "Firefighters Save Lives and Money," AFCE, Vol 16, No 2, 2008, 37.

371 John Staub, "Training Response-Ready Firefighters," AFCE, Vol 18, No 2, 2010, 28.

372 MSgt. John Olsen, "Working Together in the Millennium," AFCE, Vol 9, No 2, Summer 2001, 8-9.

373 Jennifer Spanich, "Fighting Fire with Fire," AFCE, Vol 10, No 2, Summer 2002, 22-23.

374 "The Future of Air Force Firefighting," John Burt, HQ AFCESA, 22 June 2011.

375 "Air Force Renames Firefighter Heroism Award," AFCE, Vol 18, No 2, 2010, 34.

376 MSgt. Paul Fazzini, "These Gates Don't Stand Ajar," AFCE, Vol 13, No 3, Fall 2005, 16-17.

377 Ibid., 16.

378 Ibid., 17.

379 Ibid., 16-17.

380 Lois E. Walker, History of the Air Force Civil Engineer Support Agency (RCS: HAF-HO[A]7101), 1 January – 31 December 2001, Vol 1; Department of Defense, Unified Facilities Criteria (UFC) 4-010-01, DoD Minimum Antiterrorism Standards for Buildings, 8 October 2003, accessed 26 May 2011, www.wbdg.org/ccb/DOD/UFC/ufc_4_010_01.pdf.

381 Larry Hull, "Air Force Emergency Management History," AHO.

382 Sonni Sears, "The Air Force Incident Management System," AFCE, Vol 14, No 3, Fall 2006, 12-13.

383 MSgt. Michael A. Ward, "Out with the Old, In with the New," AFCE, Vol 13, No 2, Summer 2005, 30.

384 Lois E. Walker, History of the Air Force Civil Engineer Support Agency (RCS: HAF-HO[A]7101), 1 January – 31 December 2001, Vol 1, CEXR History 2001 Readiness/NBCC."

385 Michael Ates, "Safer Airfields: Doing Our Part," AFCE, Vol 10, No 2, Summer 2002, 18.

386 Air Force Tiger Team, Airfield Obstruction Reduction Initiative Report, 27 November 2000, 7, AHO.

387 Michael Ates, "Safer Airfields: Doing Our Part," AFCE, Vol 10, No 2, Summer 2002, 18

388 Air Force Tiger Team, Airfield Obstruction Reduction Initiative Report, 27 November 2000, 3, AHO.

389 Michael Ates, "Safer Airfields: Doing Our Part," AFCE, Vol 10, No 2, Summer 2002, 19.

390 Lois E. Walker, History of the Air Force Civil Engineer Support Agency (RCS: HAF-HO[A]7101), 1 January – 31 December 2001, Vol I, Chronology.

391 Mohammad Iqbal and Steve LaFreniere, "Range Rehab," AFCE, Vol 17, No 1, 2009, 18.

392 Lt. Col. Tom Dombrowsky, and David A. Brown, "Civil Engineer Explosive Ordnance Disposal Active Range Clearance Support," 2001 AFCESA History, 1 January – 30 September 2001, AHO.

393 Maj. Gen. Del Eulberg, "EOD Airmen Sacrifice and Make a Difference," AFCE, Vol 15, No 2, 2007, 8-11.

394 Teresa Hood, "For EOD, Segway is 'Da Bomb'," AFCE, Vol 12, No 2, 2004, 28.

395 A1C. Brigitte N. Brantey-Sisk, "EOD Team Trains with New Response Vehicle," 20 October 2010, www.af.mil/news/story.asp?id=123227056.

396 Karlene Leeper, "Aleut Remains Returned to Shemya Islands," AFCE, Vol 9, No 3, Fall 2001, 26.

397 2d Lt. Joshua S. Edwards, "Renovating Warren's Historic Homes," AFCE, Vol 13, No 4, Winter 2005, 29.

398 Ron Scharven, "Soil Reuse Plan Saves $10M," AFCE, Vol 9, No 3, Fall 2001, 26.

399 2d Lt. Chris Sukach and MSgt. Steve Marciniak, "Dover Reaches Environmental Milestone," AFCE, Vol 14, No 2, 2006, 30.

400 "The Enablers: Interview with Col. David W DeFoliart," AFCE, Vol 9, No 4, Winter 2001, 12.

401 Teresa Hood, "This Island's for the Birds," AFCE, Vol 12, No 3, 2004, 6-7.

402 Memorandum, HQ USAF/ILE to Multiple Addressees, Subj: Sustainable Development Policy, 19 Dec 2001, AHO.

403 Paula Shaw and Tim Adams, "Sustainable Facilities: An Air Force Tradition," AFCE, Vol 16, No 3, 2008, 12.

404 Maj. Gen. Del Eulberg, "Meeting Our Energy Challenges," AFCE, Vol 16, No 3, 2008, 4.

405 Gil Dominguez, "'Sustainability' Not Just Another Buzzword," AFCE, Vol 17, No 1, 2009, 27.

406 Paula Shaw and Tim Adams, "Sustainable Facilities: An Air Force Tradition," AFCE, Vol 16, No 3, 2008, 12.

407 SSgt. Tanya Holditch and 1st Lt. Nick Plante, "Keesler Leads with LEED Home," AFCE, Vol 16, No 3, 2008, 40.

408 Paula Shaw and Tim Adams, "Sustainable Facilities: An Air Force Tradition," AFCE, Vol 16, No 3, 2008, 12.

409 A1C. Christopher Reel, "Fitness center at Tyndall receives LEED Platinum award, 25 April 2011, www.af.mil/news/story.asp?id=123253212

410 Jeffrey Nielson, "Vegetative Roofing," AFCE, Vol 16, No 2, 2008, 20-22.

411 Michael A. Ward, "Air Force Water, Energy Conservation Efforts Earn Federal Awards," The CE, Vol 8, No 4, Winter 2000-2001, 31.

412 "Preserving and Enhancing the Environment, 2001 Air Force an Secretary of Defense Environmental Award Winners," AFCE, Vol 10, No 1, Spring 2002, 34; Bill Autin, "CE Energy, Water Managers Earn Federal Awards," AFCE, Vol 10, No 3, Winter 2002, 25.

413 "CE Energy, Water Managers Earn Federal Awards," AFCE, Vol 11, No 4, Winter 2003. 25.

414 "Energy Program Wins Again," AFCE, Vol 14, No 2, 2006, 31.

415 Gary Hein and Linda Sisk, "Energy Savings Performance Contracts," AFCE, Vol 16, No 3, 2008, 9.

416 Bullet Background Paper on Air Force Facility Energy Program History, AHO.

417 Larry Strother, "Monitoring Energy Use with Meters," AFCE, Vol 16, No 3, 2008, 13.

418 United States Air Force Infrastructure Energy Strategic Plan, 2008, AHO; Gary Hein and Linda Sisk, "Energy Savings Performance Contracts," AFCE, Vol 16, No 3, 2008, 9.

419 Kim Holmes, "Renewable Energy in the Air Force," AFCE, Vol 16, No 3, 2008, 10.

420 Maj. Gen. Del Eulberg, "Meeting Our Energy Challenges," AFCE, Vol 16, No 1, 2008, 6.

421 Ibid.; Linda Sisk, "Meeting EISA 2007 Goals," AFCE, Vol 16, No 3 Fall 2008: 15; Kevin Wahlstrom, "Energy Savings Performance Contracts," AFCE, Vol 12, No 2, Summer 2004, 14.

422 Maj. Gen. Del Eulberg, "Energy Awareness: Everyone's Responsibility," AFCE, Vol 16, No 3, 2008, 3.

423 Ibid.

424 Joseph Bodgan, "Energy Awareness Transforms McGuire," AFCE, Vol 16, No 1, 2008, 16.

425 Mike Santoro, "Renewable Energy – An Investment in Our Future," AFCE, Vol 11, No 4, Winter 2003,

12.

426 Ibid.

427 Bullet Background Paper on Air Force Facility Energy Program History, AHO.

428 "Energy Program Wins Again," AFCE, Vol 14, No 2, 2006, 31.

429 Jennifer Elmore, "Studies Identify Energy Sources at Bases," AFCE, Vol 18, No 2, 2010, 9.

430 Kim Holmes, "Renewable Energy in the Air Force," AFCE, Vol 16, No 3, 2008, 11.

431 Ibid.

432 Jennifer Elmore, "Studies Identify Energy Sources at Bases," AFCE, Vol 18, No 2, 2010, 9.

433 Quinn Hart, "Air Force Space Command Turns to Wind Power," AFCE, Vol 9, No 3, 2001, 22.

434 Charles H. Clinchard RA, Gary Seifert, Craig Miller, and Shawn West, "Ascension Island Wind Farm," AFCE, Vol 12, No 2, 2004, 12.

435 Ron Scharven, "Lackland Turns to 'Windtricity' as Energy Source," Air Force Print News, 11 October 2002, accessed 3 February 2011, www.af.mil/stories/story_print.asp?storyID=101102285.

436 Ron Scharven, "'Windtricity' Supplies Power to Texas Base," CenterViews, Vol 8, No 4, Fall-Winter 2002, 4.

437 Tommie Baker, "Steady Winds Blow in Fuel Savings," AFCE, Vol 17, No 1, 2009, 25.

438 2d Lt. Jennifer Richard, "Nellis to save $1 million annually with use of solar panels," 4 December 2007, www.af.mil/news/story.asp?id=123078071; Roger Williams, "Catching Some Rays at Nellis," AFCE, Vol 16, No 1, 2008, 25.

439 Sharon Gill, "Buckley AFB 'Walls In' Warmth," AFCE, Vol 16, No 1, 2008, 11, 18.

440 Maj. Gen. Del Eulberg, "Meeting Our Energy Challenges," AFCE, Vol 16, No 3, 2008, 6.

441 Gary Jacks, "H20 Alternative Sources," AFCE, Vol 16, No 3, 2008, 14.

442 Tom Denslow, "'Effluency' in Water Conservation," AFCE, Vol 12, No 2, Summer 2004, 15.

443 Maj. Brian Hughes, "Alternative Sources of Energy," AFCE, Vol 17, No 3, 2009, 18-19.

444 Lois E. Walker, History of the Air Force Civil Engineer Support Agency (RCS: HAF-HO[A]7101), 1 January – 31 December 2001, Vol I, Chronology, 2.

445 Peter Cerauskis, "One Air Force, One Portal, One Civil Engineer Community," AFCE, Vol 9, No 3, Fall 2001, 23.

446 "Changing Times: Interview with Kathleen I. Ferguson," AFCE, Vol 11, No 1, Spring 2003,13-15.

447 Jeffrey A. Coleman, "ACES on the Web," AFCE, Vol 12, No 3, 2004, 34. Col. Gus G. Elliott, Jr., "End of Tour Interview," interview by Dr. Ronald B. Hartzer, 9 August, 2006, 16-18.

448 Maj. Gen. Del Eulberg, Transformation One Year Later, video briefing, May 2008; Lt. Col. John Thomas, "Information Technology Transformation," AFCE, Vol 15, No 5, 2007, 15.

449 Lt. Col. John Thomas, "Information Technology Transformation," AFCE, Vol 15, No 5, 2007, 15.

450 Maj. Gen. Del Eulberg, "IT Transformation," AFCE, Vol 16, No 2, 2008, 4-7.

451 Ibid.

452 Maj. Gen. Del Eulberg, Transformation One Year Later, video briefing, May 2008; Lt. Col. John Thomas, "Information Technology Transformation," AFCE, Vol 15, No 5, 2007, 15.

453 Maj. Gen. Del Eulberg, "IT Transformation," AFCE, Vol 16, No 2, 2008, 4-7.

454 A7C Annual History, 2009, Section VI, n.p.

455 Lt. Col. John Thomas, "Information Technology Transformation," AFCE, Vol 15, No 5, 2007, 15.

456 Maj. Gen. Del Eulberg, "IT Transformation," AFCE, Vol 16, No 2, 2008, 4-7; Lt. Col. John Thomas, "Driving CE Transformation with NexGen IT," AFCE, Vol 17, No 2, 2009, 6.

457 Lt. Col. John Thomas, "Information Technology Transformation," AFCE, Vol 15, No 5, 2007, 15; Maj. Gen. Del Eulberg, "IT Transformation," AFCE, Vol 16, No 2, 2008, 4-7.

458 Maj. Gen. Del Eulberg, "IT Transformation," AFCE, Vol 16, No 2, 2008, 4-7.

459 Lt. Col. John Thomas, "Driving CE Transformation with NexGen IT," AFCE, Vol 17, No 2, 2009, 6.

460 Alexander Earle, "NexGen IT to Deliver Mission-focused Capabilities in 2012," AFCE, Vol 18, No 1, 2010, 12.

461 Maj. Gen. Timothy A. Byers, "Connecting the Transformation Dots," AFCE, Vol 18, No 1, 2010, 9-11.

462 Maj. Gen. Timothy A. Byers, "S-File Key to 20/20 by 2020 Success," AFCE, Vol 18, No 3, 2010, 4-5; A7C Annual History, 2009, Section VI, n.p.; A7C Annual History, 2010, Section VI, n.p.

463 Alexander Earle, "NexGen IT to Deliver Mission-focused Capabilities in 2012," AFCE, Vol 18, No 1, 2010, 12.

464 Timothy Beerman, "United States Air Force Academy GeoBase Program," ca. 2004, accessed May 2011, http://proceedings.esri.com/library/userconf/proc04/docs/pap1306.pdf.

465 Col. Brian Cullis, "A Vision of 'One Installation…One Map': U.S. Air Force GeoBase," AFCE, Vol 11, No 4, Winter 2003, 22-24.

466 Ibid.

467 Ibid., 22-23.

468 "Building a Strong GeoBase Foundation," AFCE, Vol 11, No 4, Winter 2003, 24.

469 ESRI, "GIS in Defense Installation and Environmental Management," 2007, 42, accessed 2011, www.esri.com/library/brochures/pdfs/gis-in-defense-installation.pdf.

470 Col. Brian Cullis, "A Vision of 'One Installation…One Map': U.S. Air Force GeoBase," AFCE, Vol 11, No 4, Winter 2003, 22-23.

471 MSgt. Paul C. Loeber, "An Investigation of GeoBase Mission Data Set Design, Implementation, and Usage within Air Force Civil Engineer Electrical and Utilities Work Centers," Thesis, AFIT, WPAFB, Ohio, 2005, 1, 18-23.

472 "The Three Domains of GeoBase," AFCE, Vol 11, No 4, Winter 2003, 24.

473 MSgt. Paul C. Loeber, "An Investigation of GeoBase Mission Data Set Design, Implementation, and Usage within Air Force Civil Engineer Electrical and Utilities Work Centers," Thesis, AFIT, WPAFB, Ohio, 2005, 1, 18-23

474 ESRI, "GIS in Defense Installation and Environmental Management," 2007, 10-11, accessed 2011, www.esri.com/library/brochures/pdfs/gis-in-defense-installation.pdf.

475 Maj. Gen. Timothy A. Peppe, "Explosives Site Planning – A Team Effort," AFCE, Vol 10, No 1, Spring 2002, 12-13.

476 ESRI, "GIS in Defense Installation and Environmental Management," 2007, 12, 26-29, 52, accessed 2011, www.esri.com/library/brochures/pdfs/gis-in-defense-installation.pdf.

477 "The Three Domains of GeoBase," AFCE, Vol 11, No 4, Winter 2003, 24.

478 MSgt. Paul C. Loeber, "An Investigation of GeoBase Mission Data Set Design, Implementation, and Usage within Air Force Civil Engineer Electrical and Utilities Work Centers," Thesis, AFIT, WPAFB, Ohio, 2005, 1, 18-23.

479 "The Enablers: Interview with Col. David W. Defoliart," AFCE, Vol 9, No 4, Winter 2001, 10-12; "The Three Domains of GeoBase," AFCE, Vol 11, No 4, Winter 2003, 24.

480 ESRI, "GIS in Defense Installation and Environmental Management," 2007, 6, 40, accessed 2011, www.esri.com/library/brochures/pdfs/gis-in-defense-installation.pdf.

481 "The Enablers: Interview with Col. David W. Defoliart," AFCE, Vol 9, No 4, Winter 2001, 10-12.

482 "Supporting Freedom: Interview with Brig. Gen. Patrick A. Burns," AFCE, Vol 10, No 1, Spring 2002, 4-7.

483 Capt. Marc R. Vandeveer, " GeoReach-An Evolution I Beddown Planning," AFCE, Vol 11, No 3, Fall 2003, 14-16.

484 "Trimble Wins U.S. Air Force GeoBase Program Contracts," 20 January 2004, accessed May 2011, http://investor.trimble.com/releasedetail.cfm?ReleaseID=191416.

485 ILE Annual History, 2004, Section VII.a, 10.

486 ILE Annual History, 2005, Section VI, n.p.; Col. Hal Tinsley, "GeoBase: Mapping the Future," AFCE, Vol 13, No 4, 2005, 9.

487 ESRI, "GIS in Defense Installation and Environmental Management," 2007, 21, accessed 2011, www.esri.com/library/brochures/pdfs/gis-in-defense-installation.pdf; Col. Hal Tinsley, "GeoBase: Mapping the Future," AFCE, Vol 13, No 4, 2005, 9.

488 A7C Annual History, 2006, Section IV, n.p.

489 USAF GeoBase Program Goals and Future Direction, Powerpoint presentation, Headquarters U.S. Air Force, May 2007, accessed May 2011, http://proceedings.ndia.org/jsem2007/Cray.pdf; Col. Hal Tinsley, "GeoBase: Mapping the Future," AFCE, Vol 13, No 4, 2005, 9.

490 "The Training Flightline: Interview with Col. Rusty Gilbert," AFCE, Vol 9, No 3, Fall 2001, 12-14.

491 "A Steady State of Readiness: Interview with Col. J. Carlton Tickel," The CE, Vol 8, No 4, Winter 2000-2001, 4-6.

492 "Facing the Challenges: Interview with James R. Pennino," AFCE, Vol 11, No 3, Fall, 2003, 4-7.

493 Maj. Gen. Del Eulberg, "Transforming the CE Career Field," AFCE, Vol 15, No 1, 2007, 4-7; Implementation of Civil Engineer (CE) Transformation Plan, USAF, Program Action Directive 07-02, 19 April 2007, 3, III-1-2.

494 Teresa Hood, "Command Focus: Air Force Reserve Command," AFCE, Vol 13, No 1, 2005, 4-5.

495 Mike Giniger and Ken Miller, "Holistic Approach to Air Force Utilities Privatization," AFCE, Vol 17, No 1, 2009, 14; Brian P. Stahl, Richard C. Woodworth, and Robert D. Patterson, "The Road to Revitalizing Air Force Utility System Infrastructure," AFCE, Vol 11, No 1, Spring 2003, 16.

496 Brian P. Stahl, Richard C. Woodworth, and Robert D. Patterson, "The Road to Revitalizing Air Force Utility System Infrastructure," AFCE, Vol 11, No 1, Spring 2003, 16.

497 HQ AFCESA/CENU, "Utilities Privatization FAQs," accessed March 2011, www.afcesa.af.mil/questions/topic.asp?id=1089.

498 ILE Annual History, 2004, Section VI.a.

499 "Base Realignment and Closure (BRAC)," ca. 2004, accessed January 2010, http://www.globalsecurity.org/military/facility/brac.htm.

500 Ibid.

501 Maj. Gen. L. Dean Fox, "From the Top: Transitions," AFCE, Vol 13, No 3, 2005, 2.

502 2005 Defense Base Closure and Realignment Commission Report, September 2005, iii-iv, accessed May 2011, www.brac.gov/finalreport.html.

503 Frank Smolinsky, "Halfway Through BRAC Implementation," AFCE, Vol 17, No 2, 2009, 12-13.

504 Maj. Gen. L. Dean Fox, "USAF: At Home and Abroad," TME, Vol 98, No 641, May-June 2006, 83-85.

505 Frank Smolinsky, "Halfway Through BRAC Implementation," AFCE, Vol 17, No 2, 2009, 12-13.

506 2005 Defense Base Closure and Realignment Commission Report, September 2005, vi-vii, accessed

May 2011, www.brac.gov/finalreport.html.

507 Frank Smolinsky, "Halfway Through BRAC Implementation," AFCE, Vol 17, No 2, 2009, 12-13.

508 2005 Defense Base Closure and Realignment Commission Report, September 2005, 219-221, accessed May 2011, www.brac.gov/finalreport.html.

509 Maj. Gen. L. Dean Fox, "From the Top: Transitions," AFCE, Vol 13, No 3, 2005, 2.

510 Ibid.,

511 2005 Defense Base Closure and Realignment Commission Report, September 2005, 219-221, accessed May 2011, www.brac.gov/finalreport.html.

512 AF/A7C &AF/A7S History Inputs, 2009, Section VI, n.p.

513 Maj. Gen. Earnest O. Robbins II, "Air Force: Engineering Readiness," TME, Vol 94, No 618, July-August 2002, 30-31.

514 Maj. Dan Guinan, "Air Force Involvement in the American Recovery and Reinvestment Act," AFCE, Vol 17, No 2, 2009, 11.

515 Maj. Gen. Earnest O. Robbins II, "Air Force Engineering: Global Vigilance, Reach, Power," TME, Vol 93, No 612, July-August 2001, 26.

516 Maj. Gen. L. Dean Fox, " A Rewarding Year," AFCE, Vol 12, No 2, 2004, 2.

517 Maj. Gen. Timothy A. Byers, "Air Force Engineers: Building to Last and Leading Change," TME, Vol 102, No 665, July-August 2010, 91-93.

518 SrA. Donald Church, "Design-Build Project Underway at Charleston," AFCE, Vol 9, No 1, 2001, 25.

519 MSgt. Michael A. Ward, "Back in Style Base Planners Fashion New Look for Whiteman AFB," Air Force Civil Engineer, Vol 11, No 4, Winter 2003, 19-22.

520 Mark O. Hunt, "Providing a Roost for the Raptor," AFCE, Vol 13, No 3, 2005, 9.

521 "Facing the Challenges: Interview with James R. Pennino," AFCE, Vol 11, No 3, Fall 2003, 5.

522 Maj. Gen. Earnest O. Robbins II, "Air Force Engineering: Global Vigilance, Reach, Power," TME, Vol 93, No 612, July-August 2001, 27.

523 "The Enablers: Interview with Col. David W. DeFoliart," AFCE, Vol 9, No 4, Winter 2001, 11-12.

524 Maj. Gen. Earnest O. Robbins II, "Air Force: Engineering Readiness," TME, Vol 94, No 618, July-August 2002, 31.

525 SSgt. Chris Stagner, "'Movin' On Up' at Nellis AFB," AFCE, Vol 12, No 2, 2004, 23; HQ USAF, Office of the Civil Engineer, Housing Division, " Unaccompanied Housing Design Guide," January 2006, AHO.

526 Maj. Gen. L. Dean Fox, "A Rewarding Year," AFCE, Vol 12, No 2, 2004, 2.

527 Maj. Gen. Del Eulberg, "USAF: Civil Engineering," TME, Vol 99, No 647, May-June 2007, 71.

528 Judith Teague, "Housing Program Promotes Sense of Community," AFCE, Vol 18, No 1, 2010, 21.

529 Maj. Gen. Timothy Byers, "Air Force Engineers: Building to Last and Leading Change," TME, Vol 102, No 665, May-June 2010, 92-93.

530 Dr. Ronald B. Hartzer, "Command Focus United States Air Forces in Europe," AFCE, Vol 12, No 2, 2004, 4-5.

531 Jim Weslowski, "Aviano Today," The AFCE, Vol 10, No 3, Fall 2002, 4.

532 Kent Harris, "Air Force Makes Progress," Stars and Stripes, 30 April 2004, www.stripes.com/news/aviano-will-be-humming-with-more-construction-1.19409.

533 "Bullet Background Paper on Bretella Project at Aviano," included in William M. Butler and Lt. Gen. Glen W. Moorhead III, History of Headquarters Sixteenth Air Force 1 January 2003-31 December 2003 Assigned to United States Air Forces in Europe Stationed at Aviano Air Base, Italy, Maxwell AFB, Alabama.

534 Kent Harris, "Aviano Will be Humming with More Construction," Stars and Stripes, 30 April 2004, accessed 2011, www.stripes.com/news/aviano-will-be-humming-with-more-construction-1.19409; William M. Butler and Lt. Gen. Glen W. Moorhead III, History of Headquarters Sixteenth Air Force 1 January 2003-31 December 2003 Assigned to United States Air Forces in Europe Stationed at Aviano Air Base, Italy, Maxwell AFB, Alabama.

535 United States Air Forces in Europe, Rhein-Main Transition Program Management Document, 7 November 2003, 2-3, 21, AHO.

536 Ibid., 22-27, AHO.

537 "KMCC Exchange at Ramstein opens Monday," Stars and Stripes European Edition, 19 Sep 2009.

538 GAO, "Observations on Mismanagement of the Kaiserslautern Military Community Center," 28 Jun 2007, accessed 2011, www.gao.gov/products/GAO-07-1039T; Elizabeth Newell, "Defense's Largest construction project still behind schedule, over budget," National Journal Group, Inc., Government Executive, 25 Jun 2008, accessed 2011, www.govexec.com/defense/2008/06/defenses-largest-construction-project-still-behind-schedule-over-budget/27137.

539 Stephen Escude, Ben Roth, Capt. Todd Rupright, "Big Project Presents Big Challenges," AFCE, Vol 12, No 2, 2004, 20-21.

540 Louis A. Arana-Barradas, "Ramstein's Transformation Edging Toward Fruition," AFCE, Vol 14, No 1, 2006, 30-31.

541 MSgt. John Lasky, "Ramstein Airstrip Makeover," AFCE, Vol 14, No 3, 2006, 28.

542 SSgt. Toby Dunlap, "USAFE CTS Celebrates 50 Years of Service," The CE, Vol 8, No 4, Winter 2000-2001, 29; "Unit Spotlight: Others Promise- We Produce," The CE, Vol 8, No 1, Spring 2000, 7.

543 SSgt. Toby Dunlap, “USAFE CTS Celebrates 50 Years of Service,” The CE, Vol 8, No 4, Winter 2000-2001, 29.

544 Dr. Ronald B. Hartzer, “Countdown to Closure,” AFCE, Vol 12, No 2, 2004, 6-7.

545 United States Air Forces in Europe, Rhein-Main Transition Program Management Document, 7 November 2003, 22-27, AHO.

546 Peter Smith, “Fast-Track Restoration,” AFCE, Vol 11 No 4, Winter, 2003, 25.

547 Sarah Gregory, “Building Up Andersen AFB,” AFCE, Vol 12, No 4, 2004, 27.

548 Capt. Nichole K.A. Scott and Lt. Col. Mark A. Zimmerhanzel, “Changing the Face of an Island,” Air Force Civil Engineer, Vol 16, No 1, 2008, 10.

549 Col. Patrick M. Coullahan, “Bedding Down the X-Band Radar: A new Mission Proposed for Eareckson Air Station,” AFCE, Vol 9, No 1, Spring 1999, 20-22; 2d Lt. Andrew Harris, “Tail end of the chain, tip of the sword: Eareckson AF,” Joint Base Elmendorf –Richardson News Service, 21 July 2009.

550 “The GEEM Program, Graduate Education with an Air Force Focus: Interview with Lt. Col. Alfred E. Thal,” AFCE, Vol 9, No 2, Summer 2001, 19-20.

551 Ibid.; Sgt A. J. Bosker, “AFIT Provides Advanced Degree Opportunities to NCOs,” AFCE, Vol 11, No 1, Spring 2003, 21.

552 “Opportunity Knocks, AFIT’s Graduate Education Program Boosts Air Force Careers: Interview with Col. George K. Haritos,” AFCE, Vol 9, No 2, Summer 2001, 16-17.

553 Capt. Lance D. Clark, “Views from the Field, A Student’s Perspective of AFIT,” AFCE, Vol 9, No 3, Fall 2001, 20-21.

554 Capt. Brian J. Ballweg, Capt. Ryan J. Novotny, “Expanding Design Skills,” AFCE, Vol 13, No 3, 2005, 34.

555 Capt. Jonathan Gray, Capt. Brian Ballweg, and Capt. John Volcheck, “Tech Courses On Target,” AFCE, Vol 15, No 1, 2007, 38; Col. Barry S. Mines, “Current Trends in AFIT Continuing Education,” AFCE, Vol 15, No 2, 2007, 16-17.

556 Rachel M. Walkenbach, “Joint Engineer Operations Course Overview,” Engineer, the Professional Bulletin of Army Engineers, Headquarters Department of the Army, U.S. Army Engineer School, Fort Leonard Wood, Missouri, Vol 38, PB 5-08-1, 26-27.

557 Ibid.; Maj. Chris Stoppel, “AFIT Hosting Summer JEOC,” AFCE, Vol 16, No 1, 2008, 12.

558 See note above.

559 Maj. Christopher Stoppel, “Improving Contingency Education,” AFCE, Vol 16, No 3, 2008, 34-35.

560 Rachel M. King (formerly Rachel M. Walkenbach) and Dwayne E. Boeres, “JEOC, Joint Engineer Operations Course,” Engineer, the Professional Bulletin of Army Engineers, Headquarters Department of the Army, U.S. Army Engineer School, Fort Leonard Wood, Missouri, Vol 38, PB 5-09-1, 26-27; Lt. Col. Shawn P. Howley and Maj. Charles R. McGinnis, “Joint Engineer Operations Course: A Combined Approach,” Engineer, the Professional Bulletin of Army Engineers, Headquarters Department of the Army, U.S. Army Engineer School, Fort Leonard Wood, Missouri, Vol 41, PB 5-11-1, 26-27.

561 CMSgt. Clarence H. Walsh, “AFIT Course Hones Strategic Thinking for Enlisted Civil Engineers,” AFCE, Vol 17, No 1, 2009, 29.

562 Maj. David Gwisdalla and Capt. Joel Sloan, “Civil and Environmental Engineering at the U.S. Air Force Academy,” AFCE, Vol 15, No 2, 2007, 20

563 Ibid.

564 Ibid., 20-21.

565 C1C. Matt Mumm and C1C. Will Ferries, “Not Just HORSE-ing Around,” Air Force Civil Engineer, Vol 13, No 4, 2005, 28.

566 Maj. David Gwisdalla and Capt. Joel Sloan, “Civil and Environmental Engineering at the U.S. Air Force Academy,” AFCE, Vol 15, No 2, 2007, 20-21.

567 Ibid., 22-23.

568 Maj. Don Ohlemacher, Capt. Patrick Suermann, and Dr. Jim Pocock, “Building a Project Manager,” AFCE, Vol 13, No 3, 2005, 32-33.

569 MSgt. Austin Carter, “Keeping the Promise, New Strategies for Providing Quality Technical Training to Utilities Craftsmen,” AFCE, Vol 9, No 1, Spring 2001, 18-19; “Trained and Ready Airmen – Fundamental to CE Mission Success: Interview with CMSgt. Michael F. Doris,” AFCE, Vol 9, No 1, Spring 2001, 5.

570 MSgt. Austin Carter, “Keeping the Promise, New Strategies for Providing Quality Technical Training to Utilities Craftsmen,” AFCE, Vol 9, No 1, Spring 2001, 18-19.

571 SSgt. Faith Kassan, “CE Troops Wave the Silver Flag,” AFCE, Vol 9, No 3, Fall 2001, 18-19.

572 Maj. David B. Chisenhall, Jr., “Integrating Training,” AFCE, Vol 11, No 1, Spring 2003, 22-23.

573 Letha Cozart, “Stepping up to the Challenge,” AFCE Vol 8, No 2. Summer 2000, 18-27; “Readiness Challenge VIII Planning Underway,” AFCE, Vol 19, No 2, Summer 2001, 30; “Readiness Challenge VIII Canceled for 2002,” AFCE, Vol 9, No 4, Winter 2001, 32; “Readiness Challenge VIII Postponed Indefinitely,” AFCE, Vol 10, No 3, Fall/Winter 2002, 21.

574 SSgt. Simon Wess, “Dedicated Instructors, Excellent Facilities,” AFCE, Vol 9, No 3, Fall 2001, 15.

575 MSgt. Robert Bartlebaugh, “The Magnificent 7, Training Tomorrow’s Air Force Civil Engineers Today,” AFCE, Vol 10, No 1, Spring 2002, 24.

576 "Maximum Combat Support; Interview with Brig. Gen. Del Eulberg," AFCE, Vol 11, No 4, Winter 2003, 6-7.

577 Ibid.

578 Lt. j.g. Shay Meskill, "'Horse Training Solves Real Problem," AFCE, Vol 16, No 1, 2008, 16; CMSgt. Karl Deutsch, "RED HORSE Saddled Up and Ready," AFCE, Vol 16, No 1, 2008, 14-15.

579 Stephanie Ritter, "EOD: Defending the Base One Threat at a Time," 355th Wing Public Affairs Office, n.d., AHO.

580 Michael Werner, "A Principal Mission with a Nuclear Focus," AFCE, Vol 18, No 2, 2010, 30-32.

581 James Prater, "CoBRA Strikes at Warrior Training," AFCE, Vol 17, No 2, 2009, 22-23.

582 John T. Correll, "New Horizons for the Total Force," Air Force Magazine, Vol 85, No 8, August 2002, 61; Teresa Hood, "Command Focus, Air National Guard," AFCE, Vol 13, No 4, 2005, 5; Teresa Hood, "Guard Provides Hands-On Training," AFCE, Vol 13, No 4, 2005, 6-7.

583 "Putting People First: Interview with Maj. Gen. L. Dean Fox," AFCE, Vol 11, No 2, Summer 2003, 4-8.

584 Lt. Col. Gregory J. Schmidt, "Filling the Joint Engineer Gap – Preparing to Staff a JTF," The CE, Vol 8, No 2, Summer 2000, 28-29.

585 MSgt. Michael A. Ward, "A New Understanding," AFCE, Vol 12, No 1, 2004, 11.

586 ILE, Annual History, Section VI.y, 2004, n.p.

587 "Listen, Learn and Lead: Interview with Maj. Gen. Del Eulberg," AFCE, Vol 14, No 3, 2006, 4-9.

588 Maj. Gen. Earnest O. Robbins II, "We're All on the Same Team," The CE, Vol 8, No 3, Fall 2000, 2; Maj. Gen. Earnest O. Robbins II, "Air Force: New Challenges, New Solutions," TME, Vol 92, No 604, March-April 2000, 48-51.

589 "Putting People First: Interview with Maj. Gen. L. Dean Fox," AFCE, Vol 11, No 2, Summer 2003, 4-8; ILE Annual History 2004, Section VI.x, 8.

590 Joint Engineer Operations, Joint Publication 3-34, 2007, I-7.

591 Maj. Gen. Earnest O. Robbins II, "Civil Engineering After the Gulf War: A New Focus," AFCE, Vol 9, No 1, Spring 2001, 2.

592 Maj. Gen. Earnest O. Robbins II, "Air Force: New Challenges, New Solutions," TME, Vol 92, No 604, March-April 2000, 48-51.

593 "Relevant, Right-sized, and Ready: An Interview with the Air Force Civil Engineer, Brig. Gen. Earnest O. Robbins II," The CE, Vol 7, No 3, Fall 1999, 4-9.

594 Maj. Gen. Earnest O. Robbins II, "Air Force Engineering: Global Vigilance, Reach, Power," TME, Vol 93, No 612, July-August 2001, 25-27.

595 Letha Cozart, "Chiefs Panel Meets at Luke," The CE, Vol 8, No 3, Fall 2000, 20-21.

596 Maj. Gen. Earnest O. Robbins II, "The Expeditionary Aerospace Force Steps Forward," The CE, Vol 8, No 1, Spring 2000, 2.

597 Maj. Shannon E. O'Boyle, "Today's Air Expeditionary Force: A Time for Change," Research Report, Faculty of Air Command and Staff College, Air University, Maxwell AFB, Alabama, April 2007, 3-4.

598 Maj. Gen. Earnest O. Robbins II, "Evolving with the Aerospace Expeditionary Force," AFCE, Vol 10, No 1, Spring 2002, 2.

599 Maj. Gen. Earnest O. Robbins II, "Air Force Civil Engineers – Serving Proudly," AFCE, Vol 9, No 4, Winter 2001, 2.

600 Maj. Gen. Earnest O. Robbins II, "Air Force: Engineering Readiness," TME, Vol 94, No 618, July-August 2002, 30-31.

601 Maj. Shannon E. O'Boyle, "Today's Air Expeditionary Force: A Time for Change," Research Report, Faculty of Air Command and Staff College, Air University, Maxwell AFB, Alabama, April 2007, iv, 4-6.

602 Ibid., 7.

603 Ibid., 7-9.

604 SrA. Kara Manning, "The Air Force Civil Engineer Tours SWA," AFCE, Vol 13, No 2, 2005, 20; Maj. Gen. L. Dean Fox, "USAF: At Home and Abroad," TME, Vol 98, No 641, May-June 2006, 83-85.

605 Maj. Gen. Earnest O. Robbins II, "Evolving with the Aerospace Expeditionary Force," AFCE, Vol 10, No 1, Spring 2002, 2.

606 "Putting People First: Interview with Maj. Gen. L. Dean Fox," AFCE, Vol 11, No 2, Summer 2003, 4-8.

607 SMSgt. Dennis Cook, "New UTCs for CE Teams," AFCE, Vol 15, No 3, 2007, 11-12.

608 Ibid.

609 Maj. Gen. L. Dean Fox, "Back to the Bases," TME, Vol 96, No 630, July-August 2004, 39-40.

610 Maj. Gen. L. Dean Fox, "A Rewarding Year," AFCE, Vol 12, No 2, 2004, 2.

611 AFCE Almanac, Vol 16, No 4, 2008, 5.

612 Maj. Gen. Timothy A. Byers, "Air Force Engineers: Building to Last and Leading Change," TME, Vol 102, No 665, May-June 2010, 91-93.

613 Department of the Air Force, Air Force Handbook 10-222, "Civil Engineer Guide to Expeditionary Force Protection," Vol 3, 1 May 2008, 25; 32

614 Lois E. Walker, History of the Air Force Civil Engineer Support Agency (RCS: HAF-HO[A]7101), 1

January – 31 December 2001, Vol I, Chronology.

615 Letha Cozart, "Responding to Tragedy: Operation Noble Eagle," AFCE, Vol 9, No 3, Fall 2001, 4-5; Lt. Col. Gregory A. Cummings and Lt. Col. R. John Martin, "At WAR with Terrorism," AFCE, Vol 9, No 4, Winter 2001, 4-5.

616 Letha Cozart, "Responding to Tragedy: Operation Noble Eagle," AFCE, Vol 9, No 3, Fall 2001, 5-6.

617 Ibid., 4.

618 Ibid., 4-6.

619 Maj. Richard C. Sater, "A Life-Saving Mission," AFCE, Vol 9, No 3, Fall 2001, 7.

620 Letha Cozart, "Responding to Tragedy: Operation Noble Eagle," AFCE, Vol 9, No 3, Fall 2001, 4-6; Adam J. Hebert, "Homeland Air Force," Air Force Magazine, Vol 87, No 1, January 2004, 37; Lt. Col. Gregory A. Cummings and Lt. Col. R. John Martin, "At WAR with Terrorism," AFCE, Vol 9, No 4, Winter 2001, 4-5; Dr. Rebecca Grant, "The War of 9/11, Air Force Association Special Report, Arlington, Virginia, 2005, 15.

621 Adam J. Hebert, "Homeland Air Force," Air Force Magazine, Vol 87, No 1, January 2004, 37-38; Adam J. Hebert, "Noble Eagle Without End," Air Force Magazine, Vol 88, No 2, February 2005, 44.

622 Dr. Rebecca Grant, The War of 9/11, Air Force Association Special Report, Arlington, Virginia, 2005, 4-5.

623 "CENTAF re-establishes CE Function," AFCE, Vol 10, No 1, Spring, 2002, 7.

624 "No One Comes Close!: Interview with Col. Tom Ryburn," AFCE, Vol 10, No 2, Summer, 2002, 4-6.

625 Forrest L. Marion, "Building USAF 'Expeditionary Bases' for Operation Enduring Freedom – Afghanistan, 2001-2002," Air & Space Power Journal, Chronicles Online Journal, 18 November 2005, accessed April 2011, www.airpower.au.af.mil/airchronicles/cc/marion.html.

626 "Supporting Freedom: Interview with Brig. Gen. Patrick A. Burns," AFCE, Vol 10, No 1, Spring 2002, 5.

627 Lt. Col. Gregory A. Cummings and Lt. Col. R. John Martin, "At War with Terrorism," AFCE, Vol 9, No 4, Winter 2001, 5; Forrest L. Marion, "Building USAF 'Expeditionary Bases' for Operation Enduring Freedom – Afghanistan, 2001-2002," Air & Space Power Journal, Chronicles Online Journal, 18 November 2005, accessed April 2011, www.airpower.au.af.mil/airchronicles/cc/marion.html.

628 Forrest L. Marion, "Building USAF 'Expeditionary Bases' for Operation Enduring Freedom – Afghanistan, 2001-2002," Air & Space Power Journal, Chronicles Online Journal, 18 November 2005, accessed April 2011, www.airpower.au.af.mil/airchronicles/cc/marion.html.

629 Ibid.; Maj. Jeff Perham, 374th CES, Moody AFB, Georgia, "Operation Enduring Freedom Interview," 16 Apr 2002, 15, AHO.

630 Forrest L. Marion, "Building USAF 'Expeditionary Bases' for Operation Enduring Freedom – Afghanistan, 2001-2002," Air & Space Power Journal, Chronicles Online Journal, 18 November 2005, accessed April 2011,www.airpower.au.af.mil/airchronicles/cc/marion.html.

631 Ibid.

632 Ibid.; John Hendren, "Beddown in Bishkek," Air Force Magazine, Vol 85, No 7, July 2002, 58.

633 MSgt Randy G. Bergeron, Deployment of the 86th Contingency Response Group to Kyrgyzstan (USAFE Historical Study 2002, Mar 02), pp 64-74.; Forrest L. Marion, "Building USAF 'Expeditionary Bases' for Operation Enduring Freedom – Afghanistan, 2001-2002," Air & Space Power Journal, Chronicles Online Journal, 18 November 2005, accessed April 2011, www.airpower.au.af.mil/airchronicles/cc/marion.html.

634 Forrest L. Marion, "Building USAF 'Expeditionary Bases' for Operation Enduring Freedom – Afghanistan, 2001-2002," Air & Space Power Journal, Chronicles Online Journal, 18 November 2005, accessed April 2011, www.airpower.au.af.mil/airchronicles/cc/marion.html.

635 SSgt. Pamela Smith, "Meeting the Challenge," AFCE, Vol 11, No 2, Summer 2003, 13.

636 Forrest L. Marion, "Building USAF 'Expeditionary Bases' for Operation Enduring Freedom – Afghanistan, 2001-2002," Air & Space Power Journal, Chronicles Online Journal, 18 November 2005, accessed April 2011, www.airpower.au.af.mil/airchronicles/cc/marion.html.

637 Peter Grier, "The RED HORSE Way," Air Force Magazine, Vol 86, No 2, February 2003, 72-73; Lt. Col. Michael P. Skomrock, "At the Tip of the Spear: RED HORSE Performs Runway Repair under Cover of Darkness," AFCE, Vol 11, No 1, Spring 2003, 6-7.

638 Lt. Col. Michael P. Skomrock, "At the Tip of the Spear: RED HORSE Performs Runway Repair under Cover of Darkness," AFCE, Vol 11, No 1, Spring 2003, 6-7, 8.

639 Ibid., 6-7; Peter Grier, "The RED HORSE Way," Air Force Magazine, Vol 86, No 2, February 2003, 72-73.

640 Maj. William K. Giezie, "Taking the Reigns, (sic)" AFCE, Vol 11, No 2, Summer 2003, 25.

641 Ibid.

642 Ibid., 23.

643 Forrest L. Marion, "Building USAF 'Expeditionary Bases' for Operation Enduring Freedom – Afghanistan, 2001-2002," Air & Space Power Journal, Chronicles Online Journal, 18 November 2005, accessed April 2011, www.airpower.au.af.mil/airchronicles/cc/marion.html.

644 "Service Before Self," AFCE, Vol 9, No 4, Winter 2001, 7; Daniel L. Haulman, "Footholds for the Fighting Force," Air Force Magazine, Vol 89, No 2, February 2006, 78; Maj. Gen. Earnest O. Robbins, II, "Stay the Course," AFCE, Vol 9, No 3, Fall 2001, 2.

645 Forrest L. Marion, "Building USAF 'Expeditionary Bases' for Operation Enduring Freedom – Afghanistan, 2001-2002," Air & Space Power Journal, Chronicles Online Journal, 18 November 2005, accessed April 2011, www.airpower.au.af.mil/airchronicles/cc/marion.html; SrA. Matt Donegan, "Ramping Up an Air Base: RED HORSE buildings MILCON Project in Qatar," AFCE, Vol 10, No 1, Spring 2002, 10-11; Peter Grier, "The RED HORSE Way," Air Force Magazine, Vol 86, No 2, February 2003, 70-71; Daniel L. Haulman, "Footholds for the Fighting Force," Air Force Magazine, Vol 89, No 2, February 2006, 78.

646 Forrest L. Marion, "Building USAF 'Expeditionary Bases' for Operation Enduring Freedom – Afghanistan, 2001-2002," Air & Space Power Journal, Chronicles Online Journal, 18 November 2005, accessed April 2011, www.airpower.au.af.mil/airchronicles/cc/marion.html.

647 Capt. Ryan J. Novotny, "RED HORSE Triumphs with Technology," AFCE, Vol 11, No 1, Spring 2003, 5-6.

648 Ibid., 5.

649 Ibid., 6-7.

650 Ibid., 7.

651 Forrest L. Marion, "Building USAF 'Expeditionary Bases' for Operation Enduring Freedom – Afghanistan, 2001-2002," Air & Space Power Journal, Chronicles Online Journal, 18 November 2005, accessed April 2011, www.airpower.au.af.mil/airchronicles/cc/marion.html; Maj. George Runkle, "One Team, One Fight," AFCE, Vol 10, No 2, Summer 2002, 10.

652 Forrest L. Marion, "Building USAF 'Expeditionary Bases' for Operation Enduring Freedom – Afghanistan, 2001-2002," Air & Space Power Journal, Chronicles Online Journal, 18 November 2005, accessed April 2011, www.airpower.au.af.mil/airchronicles/cc/marion.html; Dr. Ronald B. Hartzer, USAF Fact Sheet RED HORSE History, June 2007, accessed April 2011, www.afcesa.af.mil/library/factsheets.

653 SSgt. Pamela Smith, "Meeting the Challenge," AFCE, Vol 11, No 2, Summer 2003, 12.

654 A1C. Jasmine Campa, "Eielson 'Icemen' Battle Blazes in Afghanistan," AFCE, Vol 11, No 1, Spring 2003, 8-9.

655 SSgt. Pamela Smith, "Meeting the Challenge," AFCE, Vol 11, No 2, Summer 2003, 13.

656 Ibid.

657 Ibid., 14.

658 Daniel L. Haulman, "Footholds for the Fighting Force," Air Force Magazine, Vol 89, No 2, February 2006, 78.

659 "No One Comes Close!: Interview with Col. Tim Ryburn," AFCE, Vol 10, No 2, Summer 2002, 6.

660 Maj. Derek Ferland, "Closing K2," AFCE, Vol 14, No 1, 2006, 12-13.

661 SSgt. Oshawn Jefferson, "FET Keeps Bagram Improving, Growing," AFCE, Vol 15, No 3, 2007, 26-27.

662 Kent Harris, "Newer Buildings Replacing Plywood Huts at Bagram," Stars and Stripes, 31 May 2008, accessed April 2011, www.stripes.com.

663 SSgt. Rachel Martinez, "Civil Engineer Crews Improve Bagram Infrastructure," USAF Print News, 12 December 2008, n.p., accessed 2011, www.af.mil/news/story.asp?id=123127806.

664 Maj. Gen. Del Eulberg, "Building Partnerships Through Reconstruction," AFCE, Vol 17, No 1, 2009, 6-7.

665 Capt. Shawn Kreuzberger, "Engineering from a PRT Perspective," AFCE, Vol 17, No 3, 2009, 13.

666 "Civil Engineers Build Partnership Capacity in Afghanistan," The Engineer's Compass, Vol 1, No 2, October 2008, 3.

667 Capt. Vincent A. Rea, "Assault Airfield," AFCE, Vol 17, No 3, 2009, 16-17; SSgt. Stacia Zachary, "RED HORSE Airmen Bring Combat Outpost into Fight," USAF Print News, 16 September 2009, n.p., accessed 2011, www.centaf.af.mil/news/story.asp?id=123168015.

668 Capt. W. Donald Horn, "Putting the Red in Readiness," AFCE, Vol 19 No3, 2011, 14-15.

669 Maj. Kevin Osborne, "History in the Making: Birth of the Expeditionary Prime BEEF Squadrons in Afghanistan," AFCE, Vol 18, No 1, 2010, 14-15; 1st Lt. John Kim, "577 Expeditionary Prime BEEF Group Enhance U.S. Forces-Afghanistan Installation Support," USAF Print News, 28 December 2010, n.p., accessed 2011, www.bagram.afcent.af.mil/news/story.asp?id=123236314; Capt. Ben Carlson, Lt. Col. Randy Whitecotton, Lt. Col. J.D. Brands, and Maj. Eric Sosa, "The Proof is in the Product," AFCE, Vol 18, No 3, 2010, 20.

670 Capt. Ben Carlson, Lt. Col. Randy Whitecotton, Lt. Col. J.D. Brands, and Maj. Eric Sosa, "The Proof is in the Product," AFCE, Vol 18, No 3, 2010, 20-21.

671 Department of the Air Force, By Order of the Secretary of the Air Force, Air Force Pamphlet 10-219, Volume 1, "Contingency and Disaster Planning," 9 June 2008, 204-205; 1st Lt. Eric H. Mannion, "Military Airfield Revival, RED HORSE Provides Peacetime Engineer Support to Camp Snoopy," The CE, Vol 8, No 4, Winter 2000-01, 8-10.

672 AFCE Staff Report, "CE Goes to War," AFCE, Vol 11, No 1, Spring 2003, 4.

673 Lois E. Walker, History of the Air Force Civil Engineer Support Agency (RCS: HAF-HO[A]7101), 1 January – 31 December 2001, Vol I, Chronology.

674 Department of the Air Force, By Order of the Secretary of the Air Force, Air Force Pamphlet 10-219, Volume 1, "Contingency and Disaster Planning," 9 June 2008, 205.

675 Capt. Michael Dunlap, SMSgt. Charles A. Dewar, and MSSgt. Robert Stewart, "Special Efforts: Air Force Special Operations CEs Respond Quickly and Expertly to OIF Missions," AFCE, Vol 11, No 4, Winter

2003, 10; Department of the Air Force, By Order of the Secretary of the Air Force, Air Force Pamphlet 10-219, Volume 1, "Contingency and Disaster Planning," 9 June 2008, 205.

676 Capt. Michael Dunlap, SMSgt. Charles A. Dewar, and MSSgt. Robert Stewart, "Special Efforts: Air Force Special Operations CEs Respond Quickly and Expertly to OIF Missions," AFCE, Vol 11, No 4, Winter 2003, 10-11.

677 AFCE Staff Report, "CE Goes to War," AFCE, Vol 11, No 1, Spring 2003, 4.

678 Ibid.

679 Adam J. Hebert, "Adventures in Bare Bones Basing," Air Force Magazine, Vol 86, No 10, October 2003, 71-73.

680 Maj. Jon Anderson and MSgt. Mike Hague, "Air Expeditionary Warriors, Buzz and Boom," AFCE, Vol 11, No 2, Summer 2003, 16; Capt. Karson Sandman, "Air Expeditionary Warriors, Beddown at a Bare Base," AFCE, Vol 11, No 2, Summer 2003, 17.

681 Maj. Jon Anderson, "Air Expeditionary Warriors, No More Bare Bases," AFCE, Vol 11, No 2, Summer 2003,16-17; Maj. Jon Anderson, "Tallil Services and CE Troops Help Make Expeditionary Life Less 'Expeditionary,'" The Tallil Times, Vol 1, No 3, 30 May 2003, 6-7; MSgt. Deb Smith, "RED HORSE Team Arrives," The Tallil Times, Vol 1, No 7, 27 June 2003, 1.

682 MSgt. Don Perrien, "Bigger & Better, 407th ECES Builds Tallil Air Base from Barren Landscape to Busy City," The Tallil Times, Vol 1, No 12, 1 August 2003, 6.

683 MSgt. Don Perrien, "Tent City Floor Project Begins," The Tallil Times, Vol 1, No 18, 12 September 2003, 1.

684 Airman 1st Class Kara Philip, "Support, Teamwork Go Hand-in-Hand," The Tallil Times, Vol 1, No 23, 17 October 2003, 4.

685 MSgt. Jon Hanson, "Keeping It Cool, HVAC in Iraq," AFCE, Vol 14, No 2 2006, 22.

686 TSgt. Paul Dean, "407th ECES Expands Clinic," AFCE, Vol 13, No 4, 2005, 23.

687 Interview, Maj. Richard Reid and MSgt. David Moreno with Dr Ronald B. Hartzer, 7 Oct 2003, AHO.

688 Department of the Air Force, By Order of the Secretary of the Air Force, Air Force Pamphlet 10-219, Volume 1, "Contingency and Disaster Planning," 9 June 2008, 206-207.

689 TSgt. Brian Davidson, "Keeping the Water Flowing," AFCE, Vol 13, No 3, 2005, 19.

690 1st Lt. Eric D. Omundson, "Red Tail Engineers Keep Balad Going," AFCE, Vol 16, No 2, 2008, 26-27.

691 Capt. Kevin Cramer, "Paving Your Way to Success," AFCE, Vol 13, No 4, 2005, 25.

692 Capt. James E. Adams, "Fixing Up the Joint," AFCE, Vol 16, No 1, 2008, 26-27.

693 Capt. Alesandra Neiman, "Out-Planning 'Murphy,'" AFCE, Vol 14, No 2, 2006, 20-21.

694 SSgt. Ruth Curfman, "Cementing Balad Hospital in History," AFCE, Vol 16, No 2, Summer 2008, 39.

695 Ibid.; National Museum of Health & Medicine, "Exhibit Featuring Emergency Room from Air Force Hospital in Balad, Iraq Opens at National Museum of Health & Medicine," News Release, 25 November 2008, accessed 26 May 2011, www.nmhm.washingtondc.museum/news/AF_hospital_balad.html.

696 SrA. Thomas Trower, "Firefighters Contain 2-Alarm Blaze at Balad," AFCE, Vol 16, No 3, 2008, 39.

697 1st Lt. Lisa Spilinek, "Renamed U.S. Military Base in Iraq Reflects Joint Status," USAF Print News 17 June 2008, n.p., accessed 2011, www.af.mil/news/story.asp?id=123103084.

698 Department of the Air Force, By Order of the Secretary of the Air Force, Air Force Pamphlet 10-219, Volume 1, "Contingency and Disaster Planning," 9 June 2008, 207.

699 Lt. Col. Jeffery A. Vinger, "Airmen-Soldiers in Iraq," AFCE, Vol 12, No 3, 2004, 8.

700 Interview, Col. Karl S. Bosworth, 2 February 2005, AHO; Briefing, "732d ECES" Lt. Col. Jeffrey A. Vinger, n.d. AHO; "732 EMSG Commander Exit Interview: Lessons and Observations," Col. Gary Shick, Commander, interview by Maj. Jeffery N. Wood, USCENTAF/XOL, 16 July 2005, AHO.

701 Lt. Col. Jeffery A. Vinger, "Airmen-Soldiers in Iraq," AFCE, Vol 12, No 3, 2004, 8-10.

702 Ibid., 10.

703 Ibid., 8-10.

704 Briefing, "732d ECES" Lt. Col. Jeffrey A. Vinger, n.d. Files of the AFCESA History Office.

705 Interview, Lt. Col. Jeffery A. Vinger with Dr. Ronald B. Hartzer, 3 February 2005, AHO.

706 Maj. Marie Kokotajlo, "Working Outside the Wire," AFCE, Vol 13, No 1, 2005, 8-9.

707 Ibid.

708 Ibid.

709 TSgt. Simon Wess, "Airmen Provide Labor, Expertise to Army," AFCE, Vol 16, No 1, 2008, 29.

710 SSgt. Ruth Curfman, "Lending a Hand," AFCE, Vol 16, No 2, 2008, 28.

711 "Listen, Learn and Lead: An Interview with Maj. Gen. Del Eulberg," AFCE, Vol 14, No 3, 2006, 7.

712 Maj. Gen. Del Eulberg, "Building Partnerships Through Reconstruction," AFCE, Vol 17, No 1, 2009, 6.

713 Brig. Gen. Patrick A. Burns, "Interview, Supporting Freedom," AFCE, Vol 10, No 1, Spring 2002, 4.

714 Ibid.; Forrest L. Marion, "Building USAF 'Expeditionary Bases' for Operation Enduring Freedom-Afganistan, 2001-2002," Air & Space Power Journal, Chronicles Online Journal, 18 November 2005, accessed May 2011, www.airpower.au.af.mil/airchronicles/cc/marion.html.

715 Wesley Frank Craven, and James Lea Cate, eds., The Army Air Forces in World War II, Vol 7: Services Around the World, Office of Air Force History, Washington, D.C., 1983, 301-302; Karl C. Dod, United States Army in World War II, The Technical Services, The Corps of Engineers: The War Against Japan, Office of the

Chief of Military History, United States Army, Washington D.C., 1966, 455; Ronald B. Hartzer, "Engineers Take to the Air…Again," AFCE, Vol 12, No 1, 2004, 16.

716 Capt. Kevin Osborne, "Red Horse Goes Airborne," TME, May-June 2003, 54-55.

717 Ibid.; Lt. Col. Gary Chesley and Capt. Kevin Osborne, "Jumping Horses," AFCE, Vol 10, No 3, Fall/Winter 2002, 10.

718 Lt. Col. Gary Chesley and Capt. Kevin Osborne, "Jumping Horses," AFCE, Vol 10, No 3, Fall/Winter 2002, 10-11.

719 "RED HORSE Engineer Goes Airborne," AFCE, Vol 10, No 1, Spring 2002, 30; Lt. Col. Gary Chesley and Capt. Kevin Osborne, "Jumping Horses," AFCE, Vol 10, No 3, Fall/Winter 2002, 10-11.

720 Maj. Stephen D. Wood, "Rigged, Ready and RED," AFCE, Vol 12, No 1, 2004, 12-13.

721 Maj. Hector Jamili, "RED HORSE Meets Prime BEEF," AFCE, Vol 13, No 2, 2005, 9-10.

722 Ibid.

723 Ibid.

724 Maj. Richard Sater, "Ride the RED HORSE," AFCE, Vol 15, No 1, 2007, 23.

725 SSgt. Julie Weckerlein, "RED HORSE Airmen Support Army in Southern Baghdad," USAF Print News, 9 July 2007, n.p., accessed 2011, www.af.mil/news/story.asp?id=123060052.

726 SSgt. Julie Weckerlein, "RED HORSE Airmen Support Army in Southern Baghdad," USAF Print News, 9 July 2007, n.p., accessed 2011, www.af.mil/news/story.asp?id=123060052.

727 Capt. Edward Dice, "Ready to Roll, Balad RED HORSE Airmen Undertake Convoy Missions to Get the Job Done," AFCE, Vol 16, No 1, 2008, 19.

728 Ibid.

729 SSgt. Pamela Smith, "Meeting the Challenge," AFCE, Vol 11, No 2, Summer 2003, 13; CMSgt. Art Foltz, "Defusing Explosive Situations," AFCE, Vol 11, No 3, 2003, 8-9; Maj. Jon Anderson, "Buzz and Boom," n.d., AHO; MSgt. Terry Nelson, "EOD Experts Keep Airmen Safe," Tallil Times, n.d., AHO; Maj. Robert-Couse Baker, "Cleaning Up," Citizen Airmen, December 2003.

730 CMSgt. Art Foltz, "Defusing Explosive Situations," AFCE, Vol 11, No 3, 2003, 8.

731 Maj. Gen. Del Eulberg, "Building Partnerships Through Reconstruction," AFCE, Vol 17, No 1, 2009, 4; CMSgt. Art Foltz, "Defusing Explosive Situations," AFCE, Vol 11, No 3, 2003, 9; MSgt. Joseph D. Cross II and TSgt. Anthony Blackman, "Fire in the Hole," AFCE, Vol 11, No 2, 2003, 18-19.

732 MSgt. Joseph Kunkle, "Welcome to Baghdad, a Day in the Life of an EOD Team," AFCE, Vol 11, No 3, 2003, 10-12.

733 "Contingency Year in Review," AFCE, Vol 15, No 4, 2007, 43.

734 SSgt. Pamela Smith, "Meeting the Challenge," AFCE, Vol 11, No 2, Summer 2003, 13; 1st Lt. Jeff Clark, "EOD Team Member Named 1 of 12 Outstanding Airmen of the Year," AFCE, Vol 12, No 2, 2004, 33; Maj. Robert-Couse Baker, "Cleaning Up," Citizen Airmen, December 2003.

735 "Ensign Elizabeth Allen, "EOD School Dedicates Joint Task Force Troy Memorial," U.S. Navy News Release, 11 Apr 2013; Maj.Gen. Del Eulberg, "EOD Airmen Sacrifice and Make a Difference," AFCE, Vol 15, No 2, 2007, 8-11.

736 Maj.Gen. Del Eulberg, "EOD Airmen Sacrifice and Make a Difference," AFCE, Vol 15, No 2, 2007, 8-11.

737 "Hill AFB CEs Remembered in Memorial Services," AFCE, Vol 15, No 1, 2007, 21.

738 Maj.Gen. Del Eulberg, "EOD Airmen Sacrifice and Make a Difference," AFCE, Vol 15, No 2, 2007, 8-11.

739 "Contingency Year in Review," AFCE, Vol 15, No 4, 2007, 43.

740 "Contingency Year in Review," AFCE, Vol 16, No 4, 2008, 47.

741 Maj. D. Landon Phillips, EOD Program Director, HAF A7/CXR, email 19 December 2011, AHO.

742 2d Lt. Kelly George, "EOD Airmen Receive Medals," AFCE, Vol 15, No 2, 2007, 35; "Air Force EOD Civil Engineers Honored and Remembered," AFCE, Vol 18, No 3, 2010, 34.

743 SrA. Karah Manning, "The Air Force Civil Engineer Tours SWA," AFCE, Vol 13, No, 2, 2005, 20.

744 CMSgt. Joseph Rivera, "Helping Build Iraq's Civil Defense," AFCE, Vol 12, No 3, 2004, 16-17.

745 SMSgt. Trish Freeland, "AF Firefighters Relocate, Expand Iraqi Fire Training Course," Air Force Link, 12/29/2008, viewed online; SSgt. Tim Beckham, "Airmen Train Firefighter Managers, Iraqis Graduate," Air Force Link, 2/9/2009, viewed online; Maj. Gen. Del Eulberg, "Building Partnerships Through Reconstruction," AFCE, Vol 17, No 1, 2009, 7.

746 SMSgt. John P. Smith III, "Forging the Iraqi Air Force's Fire Service," AFCE, Vol 17, No 3, 2009, 28.

747 SSgt. Nathan Gallahan, "Airmen Train Iraqis to Save Lives," Air Force Link, 3/25/2008, viewed online.

748 "Contingency Year in Review," AFCE Almanac, Vol 15, No 4, 2007, 42; "Contingency Year in Review," AFCE Almanac, Vol 16, No 4, 2008, 46; Maj. Gen. Del Eulberg, "Building Partnerships Through Reconstruction," AFCE, Vol 17, No 1, 2009, 4-7.

749 Lt. Col. Douglas P. Wise, "Promoting Stability in Iraq," AFCE, Vol 16, No 3, 2008, 30-31.

750 Capt. Emil Rebik, "Joint Deployment: Habbaniyah," AFCE, Vol 15, No 2, 2007, 24-25.

751 Capt. Josh R. Aldred, "The Journey of a Thousand Miles begins with One Step," AFCE Vol 16, No 3, 2008, 26-29; Sgt Jason Stadel, "Village of Hope Gives Iraqis New Perspective," American Forces Press Service, 7 Apr 2008; SMSgt Trish Freedland, "RED HORSE Airmen Close Chapter with Iraqis," AFCE, Vol 17, No 1,

2009, 23; Monthly Summary, 557 ERHS & 1 ERHG, Feb 2008, AHO.

752 Maj. Gen. Timothy A. Byers, "Air Force Engineers: Building to Last and Leading Change," TME, Vol 102, No 665, May-June 2010, 91-93.

753 Alicia Embrey, "First U.S. Air Force Officer Takes Command of Gulf Region Division South District, AFCE, Vol 17, No 3, 2009, 38.

754 White House Press Release: "Facts and Figures on Drawdown in Iraq," 2 August 2010, accessed May 2012, http://www.whitehouse.gov/the-press-office/facts-and-figures-drawdown-iraq.

755 Airman 1st Class Allison M. Boehm, "RED HORSE Builds up for Drawdown," USAF Print News, 6 April 2010, n.p., accessed 2011, www.332aew.afcent.af.mil/news/story.asp?id=123198410; Sgt. Chad Menegay, "All American Square Accommodates PAX Overflow," Expeditionary Times, Vol 4, No 10, 21 July 2010, 8.

756 MSgt. Darrell Habisch, "First in – Last out: Members of first RED HORSE squadron back in Iraq," 17 May 2010, accessed 2011, www.af.mil/news/story.asp?id=123204908.

757 MSgt. Michael A. Ward, "Building the ARRK," AFCE, Vol 12, No 1, Spring 2004, 6.

758 Ibid., 7.

759 Capt. Michael Dunlap, SMSgt. Charles A. Dewar, MSgt. Robert Stewart, "Special Efforts: Air Force Special Operations CEs Respond Quickly and Expertly to OIF Mission," AFCE, Vol 11, No 4, Winter 2003, 11.

760 Ibid.

761 Department of the Air Force, "Air Force Handbook 10-247, Guide to Services Contingency Planning, Beddown," 10 February 2005.

762 SSgt. Jeremy Larlee, "Providing Shelter is a BEAR," Air Force News, 22 January 2008, accessed 25 May 2011, www.af.mil/nmews/story_pring.asp?id=123083107; Airman Sondra M. Wieseler, "BEAR Goes BOB," Air Force News, 5 August 2008, accessed 25 May 2011, www.holloman.af.mil/news/story_pring.asp?id=123109418; CMsgt. Richard Sheridan, "49th Materiel Maintenance Group BEAR," Powerpoint presentation, 13 January 2009, accessed 25 May 2011, www.same-satx.org/briefs/090113-sheridan.pdf.

763 1st Lt. Michael E. Crosse, "BEAR Necessities," AFCE, Vol 11, No 4, 2003, 14-15.

764 2d Lt. Olivia Duer Nelson, "New Structure Offers Protection from Chemical Attack," AFCE, Vol 9, No 4,Winter 2001, 30.

765 Ibid.

766 "'Mechanical' Engineers," AFCE, Vol 13, No 2, 2005, 18-19.

767 TSgt. Mitch Shimmel, "A Clearing in the Desert," AFCE, Vol 9, No 1, Spring 2001, 11.

768 "EOD Evolves with Fight," Air Force Magazine, 3 April 2007, www.airforce-magazine.com/DRArchive/Pages/2007/April%202007/April%2013%202007/1090EOD.aspx.

769 Rod Fisher, Richard Peck, and Paul Sand, "Energy Initiatives for Expeditionary Bases," AFCE, Vol 18, No 3, 2010, 22.

770 Ibid., 23.

771 Ibid.

772 "RED HORSE Deploys to Israel," AFCE, Vol 10, No 1, Spring 2002, 26.

773 USCG PO3 Gail E. Dale, "CEs Bring Light in the Night," AFCE, Vol 13, No 3, 2005, 29.

774 Lt. Col. James Starnes, "The Red Bull Construction Company," AFCE, Vol 16, No 2, 2008, 8-10.

775 Ibid.

776 MC2. Nathaniel Moger, "474th ECES Continues Work at Gitmo," AFCE, Vol 16, No 2, 2008, 34.

777 Lt. Col. James Starnes, "The Red Bull Construction Company," AFCE, Vol 16, No 2, 2008, 8-10.

778 Combined Joint Task Force- Horn of Africa Fact Sheet, 2010, accessed May 2011, www.hoa.africom.mil/AboutCJTF-HOA.asp.

779 Capt. Matthew "Scott" Stanford, "RED HORSE Rides 'Round the Horn," AFCE, Vol 13, No 1, 2005, 18-20.

780 "Combined Joint Task Force – Horn of Africa," 2010, accessed May 2011, www.globalsecurity.org/military/agency/dod/cjtf-hoa.htm.

781 U.S. Africa Command, Combined Joint Task Force – Horn of Africa Projects Fact Sheet, 2011, accessed May 2011, www.hoa.africom.mil/pdfFiles/CJTF-HOA%202007-10%20Fact%20Sheet%20-%20Projects.pdf.

782 1st Lt. Megan Poyant and CMSgt. Michael Drumming, "Six Months on a Tropical Island," AFCE, Vol 13, No 2, 2005, 14-15.

783 "CE Teams Support Micronesia," AFCE, Vol 10, No 3, Fall/Winter 2002, 21-22.

784 Lois E. Walker, History of the Air Force Civil Engineer Support Agency (RCS: HAF-HO[A]7101), 1 January – 31 December 2001, Vol I, Chronology, 13.

785 "CE Teams Support Micronesia," AFCE, Vol 10, No 3, Fall/Winter 2002, 21-22.

786 1st Lt. Megan Poyant and CMSgt. Michael Drumming, "Six Months on a Tropical Island," AFCE, Vol 13, No 2, 2005, 14-15.

787 Capt. Christopher Bulson, "Island Engineering," AFCE, Vol 17, No 2, 2008, 27.

788 Ibid.

789 Teresa Hood, "Keeping the 'Pieces' in Play," AFCE, Vol 13, No 1, 2005, 6-7.

790 Ibid.

791 "New Horizons 2001: Readiness Training and Humanitarian Assistance," AFCE, Vol 9, No 2, Summer 2001, 28.

792 Maj. Rich Curry, "Success Against the Odds," AFCE, Vol 10, No 2, Summer 2002, 12-13.

793 SrA. Stephen Hudson, "RED HORSE Joins New Horizons-Jamaica," AFCE, Vol 10, No 2, Summer 2002, 13.

794 MSgt. Mike McGuire, "Building the Intangible," AFCE, Vol 12, No 2, 2004, 31.

795 Maj. Gen. L. Dean Fox, "Total Force-Supporting the Warfighter," AFCE, Vol 13, No 1, 2005, 2.

796 "Reservists Support Joint Exercises," AFCE, Vol 13, No 1, 2005, 26.

797 "CE Rotates to El Salvador 'for the children'," On-Final, 507th Air Refueling Wing, Tinker AFB, Oklahoma, July 2005, Vol 25, No 7, 4-5.

798 "Contingency Year in Review," AFCE Almanac, Vol 15, No 4, 2007, 43; Capt. Billy S. Allen, "Juntos Podemos: Together We Can," AFCE, Vol 16, No 1, 2008, 22-23.

799 New Horizons/Beyond the Horizon Factsheet, accessed March 2011, www.jtfb.southcom.mil/library/factsheets.

800 "Air Force General Hits Back Over 'Soft Power'," accessed May 2011, www.wired.com/danger-room/2009/01/air-force-gener/; "Contingency Year in Review," AFCE Almanac, Vol 16, No 4, 2008, 48.

801 "New Horizons Guyana," United States Southern Command (USSOUTHCOM)-fact file, accessed March 2011, www.southcom.mil/appssc/factFiles.php?id=123.

802 Teresa Hood, "Keeping the 'Pieces' in Play," AFCE, Vol 13, No 1, 2005, 6-7.

803 Ruby Zarzyczny, "CEs Deploy to Help Washoe Nation," AFCE, Vol 14, No 2, 2006, 33.

804 TSgt. Stephen Bailey, "Reserve Airmen Build Homes, Relationships," AFCE, Vol 15, No 2, 2007, 38.

805 MSgt. Jon Dyer, "ANG CEs Join Canadian Engineers on 'Road to High Readiness' Exercise," AFCE, Vol 17, No 3, 2009, 29.

806 Capt. Robert Baran and MSgt. Larry Lenneman, "A Well-Formed Idea," AFCE, Vol 12, No 1, 2004, 26.

807 Capt. Jerry Otto, "CEs Help 'Bail Out' Coast Guard," AFCE, Vol 12, No 2, 2004, 30.

808 SSgt. Andrea Knudson, "RED HORSE Squadrons Unite in the Fight," AFCE, Vol 14, No 2, 2006, 27.

809 Maj. Donna M. Prigmore, "Building a Brighter Future," AFCE, Vol 9, No 2, Summer 2001, 6-7.

810 Maj. Thomas DeFazio, "Prime BEEF Goes to Sea," AFCE, Vol 17, No 2, 2009, 14-17.

811 1st Lt. Dan Wilcoxen, "Special OPS CEs Respond Quickly to Haiti Earthquake," AFCE, Vol 18, No 1, 2010, 22-23; Lt. Col. John C. Blackwell, "Port-au-Prince, Haiti: CEs Key to Safer Shelter Strategy," AFCE, Vol 18, No 2, 2010, 14-15.

812 "CE Volunteers Built Homes in England," The CE, Vol 8, No 3, Fall 2000, 33.

813 "Kunsan CEs Battle Floods, Mudslides," The CE, Vol 8, No 3, Fall 2000, 32.

814 MSgt. Louis A. Adams, "From Drought to Flood," AFCE, Vol 9, No 4, Winter 2001, 24-25.

815 "CE Teams Aid Andersen Typhoon Recovery," AFCE, Vol 10, No 2, Summer 2002, 32.

816 "Tinker Tornado Damage Exceeds $10 Million," AFCE, Vol 11, No 2, Summer 2003, 32.

817 "Cleaning Up After Isabel," AFCE, Vol 11, No 3, Fall 2003, 18-19.

818 Ibid.

819 "When Stormy Winds Do Blow," AFCE, Vol 12, No 3, 2004, 18-19.

820 Maj. Gen. L. Dean Fox, "Transitions," AFCE, Vol 13, No 3, 2005, 2.

821 Maj. Gen. L. Dean Fox, "Leading the Way into a New Year…," AFCE, Vol 13, No 4, 2.

822 "Katrina Batters Keesler," AFCE, Vol 13, No 3, 2005, 6-7; 1st Lt. Nathan D. Broshear, "RED HORSE Rides to Keesler," AFCE, Vol 13, No 3, 2005, 24.

823 Msgt. Michael E. Ward, "CEMIRT's Got the Power," AFCE, Vol 13, No 3, 2005, 22.

824 Maj. Gen. L. Dean Fox, "USAF: At Home and Abroad," TME, Vol 98, No 641, May-June 2006, 83-85.

825 Teresa Hood, "CEs Put Keesler Back on Top," AFCE, Vol 14, No 3, 2006, 16-19.

826 "Contingency Year in Review," AFCE Almanac, Vol 16, No 4, 2008, 46.

827 Maj. Gen. Timothy A. Byers, "Building to New Heights," AFCE Almanac, Vol 18, No 4, 2010, 4.

Epilogue Endnotes

1 Maj. Gen. Timothy A. Byers, "Keynote Speech, AFCEC Activation Ceremony," 1 Oct 2012, Files of the AFCESA History Office, Tyndall AFB, Florida.

2 Memo, SECDEF Mr. Robert M. Gates to Secretaries of the Military Departments, "Improving Department of Defense Business Operations," 4 Jun 2010; Maj. Gen. Timothy A. Byers, CEnterline Video Script, "CE Transformation Update," 4 June 2012; Air Force Civil Engineer Strategic Communications, "CE Transformation…Accelerated," 26 March 2012, Files of AFCEC History Office, Tyndall AFB, Florida.

3 Air Force Civil Engineer Strategic Communications, "CE Transformation…Accelerated Communication Guidance Card," 14 Feb 2012, Files of AFCEC History Office, Tyndall AFB, Florida; HQ USAF/CE Strategic Communications, "CE Transformation…Accelerated," Air Force Civil Engineering Fact Sheet, Nov 2011

4 HQ USAF, Special Order GI-003, 27 Sep 2012, Files of the AFCESA History Office, Tyndall AFB, Florida; Maj. Gen. Timothy A. Byers, "Keynote Speech, AFCEC Activation Ceremony," 1 Oct 2012, Files of the AFCESA History Office, Tyndall AFB, Florida.

5 Memo, Lt. Gen. Judith L. Fedder, HQ USAF/A4/7 to Mr. Terry A. Yonkers, SAF/IE, Subj: Response to Field Operating Agency (FOA) Way Ahead, 30 July 2012," 6 Aug 2012, Files of AFCESA History Office, Tyndall AFB, Florida; HQ USAF, Program Action Directive (PAD) 12-03, "Implementation of Enterprise-Wide Civil Engineer Transformation," 26 Oct 12, 64-5.

6 HQ USAF, "CE Transformation…Accelerated Fact Sheet, Spiral 3," November 2011, Files of AFCESA History Office, Tyndall AFB, Florida; HQ USAF, Program Action Directive (PAD) 12-03, "Implementation of Enterprise-Wide Civil Engineer Transformation," 26 Oct 12, 47-60.

7 HQ USAF, Program Action Directive (PAD) 12-03, "Implementation of Enterprise-Wide Civil Engineer Transformation," 26 Oct 12, 19-23, 103; Factsheet, "Planning and Integration Directorate, 6 September 2012.

8 HQ USAF, Program Action Directive (PAD) 12-03, "Implementation of Enterprise-Wide Civil Engineer Transformation," 26 Oct 12, 107-111; Brig. Gen. Dave Howe, "CE Transformation Supplemental Video: MAJCOM CE Staff of the Future," 31 July 2012.

BIBLIOGRAPHY

SUMMARY OF SOURCES

Items from the following four sources are not cited individually in this bibliography: *Air Force Civil Engineer Magazine*; *Centerviews*; *The Military Engineer*; and, the files of the AFCEC History Office, Tyndall, AFB, Florida. Instead, the sources are summarized below to provide a better understanding of the range of information they offered for this publication. Detailed citations on all items from these sources are found within the endnotes.

Air Force Civil Engineer Magazine

Air Force Civil Engineer magazine provided a significant amount of information for this book. Articles within the publication provided applicable histories, current events, and overviews of various programs, activities, and missions. The magazine also provided personal accounts that permitted a valuable understanding of struggles and losses, as well as accomplishments.

The magazine debuted February 1, 1960 and was originally published by the Civil Engineering Center of the Air Force Institute of Technology at Wright-Patterson AFB. The new periodical was designed to be the equivalent of other military engineering journals with the broader mission of promoting increased professionalism and facilitating communication among civil engineers at the director's office, major commands, and the bases. General Minton wrote in the inaugural issue, that the purpose of the new magazine was "to provide a medium of exchange of professional ideas and information which will result in a more effective civil engineering function in the Air Force." General Minton wanted a journal that would encourage civil engineers to seek professional registration, to serve as a forum to share management improvement ideas, and to promote Air Force engineering achievements and challenges.

The magazine was published four times per year at Wright-Patterson AFB. General Minton encouraged authorship of articles and gained sponsorship of an award for the best article published each year. The yearly award was named in his honor. Throughout the years, the magazine has changed its name and format several times. The magazine's name became the *Engineering and Services Quarterly* after Services and Civil Engineering were merged in 1975. Publication of the quarterly magazine ceased in 1986 during a period of cost reduction. The Air Force Engineering and Services Center began to publish a modest newsletter in August 1988. This newsletter initially was titled the *Engineering and Services Update,* and later the *CE Update.* In April 1993, the *U.S. Air Force Civil Engineer* magazine debuted. Full color illustrations were introduced in summer 1995.

The magazine is now published quarterly by the Public Affairs staff at AFCEC, Tyndall AFB, Florida. In 1999, the magazine was made available as an online resource. It continues to provide articles regarding current and past achievements as well as information on advancing technologies, efficient solutions, and educational opportunities.

Centerviews

This magazine was produced by the Air Force Center for Environmental Excellence (AFCEE) Public Affairs office beginning in 1992. It was the official news and information publication for AFCEE and covered the center's varied activities. It was published quarterly until 2012 when AFCEE became part of the Air Force Civil Engineer Center.

The Military Engineer

Articles from *The Military Engineer* were useful particularly in providing a broad context of the challenges faced by military engineers. Topics such as airport engineering, airfield construction, training, building bases, and environmental issues were essential to understanding the Air Force civil engineer role within the larger world of military engineers.

The Military Engineer magazine began in 1909 as a collection of articles on engineering; it was named *Professional Memoirs*. The articles were circulated by the Army Engineer Bureau's School Board. During World War I the publication focused on wartime topics, including transportation related construction, medical facilities, and barracks in France. In 1919, The Society of American Military Engineers (SAME) was created and given responsibility for publishing *Professional Memoirs*, which was renamed *The Military Engineer*. The magazine included articles on the postwar military, but also covered civilian engineering techniques and new developments. During the 1950s and 1960s, topics in the magazine ranged from advancements in weapons technology to the interstate highway system and the space program. Civilian engineers increased their contributions to the magazine, producing a high percentage of articles during this period.

In 2005, *The Military Engineer* was made available as an online resource. In 2008, the name *The Military Engineer* was replaced with the acronym *TME*. The magazine continues to provide a combination of topics on engineering, covering military, technology, energy, sustainability, achievements, and current innovations.

Files of the AFCEC History Office

The AFCEC History Office is located at Tyndall AFB, Florida. The office holds a collection of current and historical information on Air Force civil engineering including: publications, AFCEC annual histories, oral history interviews, chronologies, background papers, essays, presentations, conference materials, briefings, fact sheets, theses, squadron histories, deployment summaries, photographs, manpower statistics, annual histories assembled by Air Staff agencies and commands, RED HORSE unit histories, and numerous other items related to Air Force civil engineering. The collection primarily is organized topically, and includes entire groups of material dedicated to particular squadrons, operations, projects, and themes. The files are continually updated to include information on current events and changes within the AFCESA structure.

The collection was started in 1985 and covers materials from World War I to current day. The collection continues to preserve and maintain an assembly of key documents related to the history of Air Force Civil Engineering and serves as a repository for research and analysis.

Books

Air National Guard Readiness Center. *Survey of the Architectural and Archeological Cultural Resources at the Virginia Air National Guard Installations at the Richmond International Airport, Henrico County and the State Military Reservation, Camp Pendleton, City of Virginia Beach, Virginia*. Prepared by R. Christopher Goodwin & Associates, Inc., Frederick, Maryland, 2007.

Ambrose, Stephen. *Rise to Globalism: American Foreign Policy 1938-1970*. Baltimore, Maryland: Penguin Books, Inc., 1971.

Arnold, Henry H. *Global Mission*. New York: Harper, 1949.

Beck, Alfred M., et al. *United States Army in World War II, The Technical Services, The Corps of Engineers: The War Against Germany*. Washington, D.C.: Center of Military History, U.S. Army, 1985.

Boyne, Walter J. *Beyond the Wild Blue: A History of the United States Air Force 1947-1997*. New York: St. Martin's Press, 1998.

Cameron, Fraser. *US Foreign Policy After the Cold War: Global Hegemon or Reluctant Sheriff*? 2nd ed. New York: Routledge, Taylor & Francis Group, 2005.

Courchene, Douglas E. *Pioneers with Intent: Memoirs of an Air Force Fire Fighter*. Tyndall AFB, Florida: AFCESA History Office, July 2003.

Craven, Wesley Frank, and James Lea Cate, eds. *The Army Air Forces in World War II*. Vol 1, *Plans & Early Operations, January 1939 to August 1942*. Washington, D.C.: Office of Air Force History, 1983.

———. *The Army Air Forces in World War II*. Vol 2, *Europe: Torch to Pointblank, August 1942 to December 1943*. Washington, D.C.: Office of Air Force History, 1983.

———. *The Army Air Forces in World War II*. Vol 3, *Europe: Argument to V-E Day, January 1944 to May 1945*. Washington, D.C.: Office of Air Force History, 1983.

———. *The Army Air Forces in World War II*. Vol 4, *The Pacific: Guadalcanal to Saipan, August 1942 to July 1944*. Washington, D.C.: Office of Air Force History, 1983.

———. *The Army Air Forces in World War II*. Vol 5, *The Pacific: Matterhorn to Nagasaki, June 1944 to August 1945*. Washington, D.C.: Office of Air Force History, 1983.

———. *The Army Air Forces in World War II*. Vol 6, *Men and Planes*. Washington, D.C.: Office of Air Force History, 1983.

———. *The Army Air Forces in World War II*. Vol 7, *Services Around the World*. Washington, D.C.: Office of Air Force History, 1983.

Davis, Richard G. *Anatomy of a Reform, The Expeditionary Aerospace Force*. Air Force History and Museums Program, 2003.

Dobson, Alan P. and Steve Marsh. *US Foreign Policy Since 1945*. 2nd ed. New York: Routledge Taylor & Francis Group, 2006.

Dod, Karl C. *United States Army in World War II, The Technical Services*, *The Corps of Engineers: The War Against Japan.* Washington, D.C.: Center of Military History, U.S. Army, 1966.

Duke, Simon. *United States Military Forces and Installations in Europe*. New York, New York: Oxford University Press, 1989.

Fine, Lenore and Jesse A. Remington. *United States Army in World War II, The Technical Services, The Corps of Engineers: Construction in the United States*. Washington, D.C.: Center of Military History, U.S. Army, 1989.

Fletcher, Harry R. *Air Force Bases Vol II: Air Bases Outside the United States of America*. Washington, D.C.: Center for Air Force History, U.S. Air Force, 1993.

Fowle, Barry W., ed. *Builders and Fighters: U.S. Army Engineers in World War II*. Fort Belvoir, Virginia: Office of History, U.S. Army Corps of Engineers, 1992.

Frazier, Capt. Everette. *The Saga of Tsili Tsili*. San Antonio, Texas: E.E. Frazier, 1992.

Gaddis, John Lewis. *The Cold War: A New History*. New York: The Penguin Press, 2005.

Glover, Lt. Col. Ralph C. *The History of the 808th Engineer Aviation Battalion*. SWPA File A167. Files of Air Force Historical Research Agency, Maxwell AFB, Alabama.

Goldberg, Alfred, ed. *A History of the United States Air Force*. Princeton, New Jersey: D. Van Nostrand Company, Inc., 1957. Reprint, New York: Arno Press, Inc., 1974.

Grathwol, Robert P. and Donita M. Moorhus. *American Forces in Berlin '45 – '94: Cold War Outpost*. U.S. Department of Defense, Legacy Resource Management Program, Cold War Project, Washington, D.C. 1994.

———. *Building for Peace: U.S. Army Engineers in Europe, 1945 – 1991*. Washington D.C.: Center of Military History, Corps of Engineers, U.S. Army, 2005.

Gross, Charles Joseph. *The Air National Guard and the American Military Tradition*. Washington, D.C.: Historical Services Division, National Guard Bureau, 1995.

Haggerty, Richard A., ed. *Dominican Republic: A Country Study*. Washington, D.C.: Government Printing Office, 1989. http://countrystudies.us/dominican-republic.

Haile, John and Ron Dalby. *Top Cover and Global Engagement: A History of the Eleventh Air Force*. Anchorage, Alaska: Alaska Quality Publishing, 2001.

Harrington, Daniel F. *"The Air Force Can Deliver Anything!" A History of the Berlin Airlift*. Ramstein Air Base, Germany: U.S. Air Force Europe, Office of History, U.S. Air Force, 1998.

Hearn, Chester G. *Air Force: An Illustrated History*. Minneapolis, Minnesota: Zenith Press, 2008.

Hennessy, Juliette A. *The United States Army Air Arm, April 1861 to April 1917*. Washington, D.C.: Office of Air Force History, 1985.

The History of IX Engineer Command: From its beginning to V-E Day, Schlangenbad, Germany 1945.

Hunley, J.D. *The San Antonio Real Property Maintenance Agency: A Case Study of Centralization*. History and Research Office, HQ Air Training Command, 1990.

Jamieson, Perry D. *Khobar Towers: Tragedy and Response*. Washington D.C.: Air Force History and Museums Program, U.S. Air Force, 2008.

Jamieson, Perry D. *Lucrative Targets: The U.S. Air Force in the Kuwaiti Theater of Operations*. Air Force History and Museums Programs, U.S. Air Force, Washington, D.C., 2001.

Kenney, Gen. George C. *General Kenney Reports: A Personal History of the Pacific War*. Washington, D.C.: Air Force History and Museums Program, 1997.

Lee, Ulysses. *The Employment of Negro Troops*. Washington, D.C.: Office of the Chief of Military History, U.S. Army, 1966.

Lloyd, Alwyn T. *A Cold War Legacy A Tribute to Strategic Air Command 1946 – 1992*. Missoula, Montana: Pictorial Histories Publishing Company, Inc., 1999.

Lonnquest, John C. and David Winkler. *To Defend and Deter: The Legacy of the United States Cold War Missile Program*. Champaign, Illinois: U.S. Army Construction Engineering Research Laboratories, 1996.

Manufacturers Aircraft Association, Inc. *Aircraft Year Book.* Doubleday, New York, New York: Page and Company for the Manufacturers Aircraft Association, Inc., 1920.

Maurer, Maurer. *Aviation in the U.S. Army 1919-1939*. Washington, D.C.: Office of Air Force History, U.S. Air Force, 1987.

Maurer, Maurer, ed. *The U.S. Air Service in World War I*. Vol IV, *Postwar Review*. The Albert F. Simpson Historical Research Center, Maxwell AFB, Alabama, 1978.

Mead and Hunt, Inc. "The Missile Plains: Frontline of America's Cold War, Historic Resource Study, Minuteman Missile National Historic Site, South Dakota." Prepared for U.S. Department of the Interior National Park Service Midwest Regional Office. http://www.cr.nps.gov/history/online_books/mimi/hrs.htm.

Miller, Roger G. *A Preliminary to War: The 1st Aero Squadron and the Mexican Punitive Expedition of 1916*. Washington, D.C.: Air Force History and Museums Program, 2003.

Morton, Louis. *U.S. Army in World War II: The Fall of the Philippines*. Washington, D.C.: Center of Military History, 1953.

Nalty, Bernard C., ed. *Winged Shield, Winged Sword: A History of the United States Air Force,* Vols I and II. Washington, D.C.: Air Force History and Museums Program, 1997.

Nauman, Robert Allen. *On the Wings of Modernism, The United States Air Force Academy*. Urbana and Chicago: University of Illinois Press, 2004.

Office of Air Force History. "Condensed Analysis of the Ninth Air Force in the European Theater of Operations." Washington D.C.: Office of Air Force History, 1984.

Office of the Historian HQ SAC. "Snark to Peacekeeper A Pictorial History of Strategic Air Command Missiles." HQ SAC, Offutt Air Force Base, Nebraska, 1990.

Palmer, R.R. and Joel Colton. *A History of the Modern World*. New York, New York: Alfred A. Knopf, 1978.

Peeler, Kirsten, Christine Heidenrich, Katherine E. Grandine, and Dean A. Doerrfeld. "Housing an Air Force and a Navy: The Wherry and Capehart Solutions to the Postwar Family Housing Shortage (1949-1962)." Prepared for the U.S. Department of the Air Force and the U.S. Department of the Navy by R. Christopher Goodwin and Associates, Inc., Frederick, Maryland, June 2007.

Polmar, Norman. *Strategic Air Command: People, Aircraft, and Missiles*. Annapolis, Maryland: The Nautical and Aviation Publishing Company of America, Inc., 1979.

Reynolds, Capt. Cecil L. "Construction for United States Air Forces in Europe, 8 May 1945-1 July 1947." HQ U.S. Air Force Europe, 1 August 1948.

Rudd, Gordon W. *Humanitarian Intervention: Assisting the Iraqi Kurds in Operation Provide Comfort*. U.S. Army Center of Military History, Washington, D.C., 2004.

Scales, Gen. Robert H. *Certain Victory: The US Army in the Gulf War*. Fort Leavenworth, Kansas: U.S. Army Command and General Staff College Press, 1994.

Schlicht, John. *The War in South Vietnam: The Years of the Offensive, 1965-1968*. Air Force History and Museums Program, 1999.

Schlicht, John. *A War Too Long: The USAF in Southeast Asia, 1961-1975*. Air Force History and Museums Program, 1996.

Schubert, Frank N. *Building Air Bases in the Negev: The U.S. Army Corps of Engineers in Israel, 1979-1982*. Washington, D.C.: Office of History, Corps of Engineers, 1992.

Shaw, Frederick J. "History's Footprints: USAF Continental Bases." Air Force Historical Research Agency, Maxwell AFB, Alabama, 2004.

Shaw, Frederick J., ed. *Locating Air Force Base Sites, History's Legacy*. Washington, D.C.: Air Force History and Museum Program, 2004.

Walker, Lois E., and Shelby E. Wickam. *From Huffman Prairie to the Moon: The History of Wright-Patterson AFB.* Washington, D.C.: Government Printing Office, 1986.

Webster, Donovan. *The Burma Road: The Epic Story of the China-Burma-India Theater*. New York: Farrar, Straus & Giroux, 2003.

Warnock, A. Timothy, Ed., Ed. *Short of War: Major USAF Contingency Operations*, Air Force History and Museums Program, Air University Press, Maxwell AFB, Alabama, 2000.

Winkler, David F. *Searching the Skies the Legacy of the United States Cold War Defense Radar Program.* HQ U.S. Air Force Air Combat Command, Langley AFB, Virginia, 1997.

Wolk, Herman S. *Planning and Organizing the Postwar Air Force 1943-1947*. Washington, D.C.: Office of Air Force History, U.S. Air Force, 1984.

Interviews

Ahearn, Maj. Gen. Joseph A. (USAF, Retired). "Oral History Interview." Interview by Dr. Douglas H. Merkle and Lois E. Walker. HQ AFCESA, Tyndall AFB, Florida, March 2008.

Bridges, Maj. Timothy. "Oral History Interview." Interview by Dr. Ronald B. Hartzer and Mr. Duane Knutson. HQ AFCESA, Tyndall AFB, Florida, 1 August 1991.

Byer, Capt. Jeffrey. "Oral History Interview." Interview by Dr. Ronald B. Hartzer. HQ AFCESA, Tyndall AFB, Florida, July 1991.

Crockett, Rufus D. "Oral History Interview." Interview by Lois E. Walker. HQ AFCESA, Tyndall AFB, Florida, April 2005.

Curtin, Maj. Gen. Robert H. (USAF, Retired). "Oral History Interview." Interview by Lois E. Walker and Dr. Ronald B. Hartzer. HQ AFCESA, Tyndall AFB, Florida, 2003.

Davison, Brig. Gen. Donald. Interview. 21 June 1943. Unpublished manuscript, Air Force Historical Research Agency, 638.951, Maxwell AFB, Alabama.

Fisher, Capt. Marvin N. "Oral History Interview." Interview by Dr. Ronald B. Hartzer. HQ AFCESA, Tyndall AFB, Florida, August 1991.

Flora, Mr. Gary S. (SES, Retired). "Oral History Interview." Interview by Lois E. Walker and Dr. Douglas H. Merkle. HQ AFCESA, Tyndall AFB, Florida, September 2005.

Gilbert, Maj. Gen. William D. (USAF, Retired). "Oral History Interview." Interview by Lois E. Walker. HQ AFCESA, Tyndall AFB, Florida, September 2002.

Goddard, Maj. Gen. Guy H. (USAF, Retired). "Oral History Interview." Interview by Dr. Ronald B. Hartzer and Lois E. Walker. HQ AFCESA, Tyndall AFB, Florida, February 2003.

Hicks, Lt. Col. Alfred B., Jr. "Oral History Interview." Interview by Dr. Ronald B. Hartzer and Mr. Duane Knutson. HQ AFCESA, Tyndall AFB, Florida, 23 January 1992.

Hinegardner, MSgt. William L. "Oral History Interview." Interview by Dr. Ronald B. Hartzer. HQ AFCESA, Tyndall AFB, Florida, December 1990.

Hunt, Lt. Col. Rodney L. "Oral History Interview." Interview by Dr. Ronald B. Hartzer and Duane Knutson. HQ AFCESA, Tyndall AFB, Florida, September 1991.

Leonhard, Brig. Gen. William (USAF, Retired). "Interview of Brigadier General William Leonhard, USAF (Retired)." Interview by Dr. John Lonnquest. U.S. Army Corps of Engineers Office of History, 2000-2001.

Lucas, Col. Rio G. (USAF, Retired). "Oral History Interview." Interview by Lois E. Walker. HQ AFCESA, Tyndall AFB, Florida, July 1999.

McAuliffe, Brig. Gen. Michael A. "Oral History Interview." Interview by Dr. Ronald B. Hartzer, Mr. Duane Knutson, and Mr. Norm Falk. HQ AFCESA, Tyndall AFB, Florida, July 1991.

McCarthy, Maj. Gen. James E. "Oral History Interview." Interview by Dr. Douglas H. Merkle and Lois E. Walker. HQ AFCESA, Tyndall AFB, Florida, June 2005.

McCoy, Lt. Col. Ronald P. "Oral History Interview." Interview by Dr. Ronald B. Hartzer. HQ AFCESA, Tyndall AFB, Florida, August 1991.

Mayes, Brig. Gen. Archie S. (USAF, Retired). "Oral History Interview." Interview by Lois E. Walker. AFCESA HQ, Tyndall AFB, Florida, 2000.

Meredith, Brig. Gen. William T. (USAF, Retired). "Oral History Interview." Interview by Lois E. Walker. HQ AFCESA, Tyndall AFB, Florida, December 2001.

Minton, Maj. Gen. Augustus M. (USAF, Retired). "Oral History Interview." Interview by Lois E. Walker and Dr. Ronald B. Hartzer. HQ AFCESA, Tyndall AFB, Florida, June 2001.

Norris, Maj. Richard. "Oral History Interview." Interview by Dr. Ronald B. Hartzer, Duane Knutson, and MSgt. David Beal. HQ AFCESA, Tyndall AFB, Florida, October 1991.

Patterson, Capt. Wayland H. "Oral History Interview." Interview by Dr. Ronald B. Hartzer. HQ AFCESA, Tyndall AFB, Florida, July 1991.

Peters, Brig. Gen. John D. (USAF, Retired). "Oral History Interview." Interview by Lois E. Walker and Dr. Ronald B. Hartzer. HQ AFCESA, Tyndall AFB, Florida, June 2001.

Rietman, Mr. Harry P. (Retired). "Oral History Interview." Interview by Lois E. Walker. HQ AFCESA, Tyndall AFB, Florida, November 2004.

Sanders, Maj. David, Lt. Joel Holtrop, and Lt. Brian Duffy. "Oral History Interview." Interview by Dr. Ronald B. Hartzer. HQ AFCESA, Tyndall AFB, Florida, September 1991.

Smith, Joseph H. "Oral History Interview." Interview by Lois E. Walker. HQ AFCESA, Tyndall AFB, Florida, November 2004.

Waylett, Col. Susanne M. (USAF, Retired). "Oral History Interview." Interview by Lois E. Walker. HQ AFCESA, Tyndall AFB, Florida, 2000.

Wilson, Col. Thomas F. "Oral History Interview." Interview by Dr. Ronald B. Hartzer, Duane Knutson, and Peter Hart. HQ AFCESA, Tyndall AFB, Florida, October 1991.

Wright, Maj. Gen. Clifton D., Jr. (USAF, Retired). "Oral History Interview." Interview by Lois E. Walker. HQ AFCESA, Tyndall AFB, Florida, May 2002.

Academic Theses

Ashdown, Lt. Col. Floyd A. "A History of the Warfighting Capability of Air Force Civil Engineering." Thesis, Air War College, Air University, Maxwell AFB, Alabama, 1984.

Bohlen, Col. George A. "Research Report No. 9, USAF Engineer Heavy Repair/Troop Construction Capability." Research Report, Air War College, Air University, Maxwell AFB, Alabama, 25 May 1977.

Bradham, Lt. Col. Gary C. "Integrating AF Services and MWR Organizations: Impacts, Assessment, and Recommendations." Executive Research Project for the Industrial College of the Armed Forces National

Defense University, 1992.

Brown, Jerold E. "Where Eagles Roost: A History of Army Airfields Before World War II." Ph. D. diss., Department of History, Duke University, Durham, North Carolina, September 1977.

Buckman, Lt. Col. Gerald A., Sr. "Making the Future Total Force Work." U.S. Army War College Strategy Research Project, U.S. Army War College, Carlisle Barracks, Pennsylvania, 2006. http://www.dtic.mil/cgi-bin/GetTRDoc?Location=U2&doc=GetTRDoc.pdf&AD=ADA448838.

Cannan, Maj. David M. "Base-Level Civil Engineering Forces of the Twenty-First Century." Report submitted to Air Command and Staff College, Maxwell AFB, 1984.

Card, Lt. Col. Bernard. "The Role of Engineers in the Air Force." Research report, Air War College, Air University, Maxwell AFB, Alabama, 1948.

Chiarelli, Lt. Col. Peter W. "Goldwater-Nichols Revisited: A Proposal for Meaningful Defense Reorganization." Thesis, Army War College, Air University, Maxwell AFB, Alabama, 1993.

Freeman, Lt. Col. Myron L. *USAF Force Protection: Is It Really Everyone's Responsibility?* Prepared for Air War College, Air University, Maxwell AFB, Alabama, 9 December 2002.

Griffin, Maj. Bobbie L. and Maj. George R. Velasco. "The Air Force Environmental Quality Program: A Historical Look at Air Force Efforts to Achieve Environmental Excellence." Research report, Air Command and Staff College, Maxwell AFB, Alabama, April 1996.

Harty, Lt. Col. John R. "An Analysis of Air Force Civil Engineering Research and Development Management." Research Report, Air War College, Maxwell AFB, Alabama, 1978.

Hasberry, Maj. Valerie L., U.S. Air Force. "Engineering the Future: Organizing United States Air Force Civil Engineers for Joint Operations and the Projection of Airpower." Research paper submitted to U.S. Marine Corps Command and Staff College, Quantico, Virginia, 2002.

Johnson, Lt. Col. Jack L. *Rebasing the 401st Tactical Fighter Wing—Here, There, or Anywhere?* Prepared for the National War College. 22 February 1990. http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA437312.

Jackson, Ralph E. "Relocating the 401st Tactical Fighter Wing." Thesis AFIT, submitted to University of Maryland, College Park, 3 May 1991. http://www.dtic.mil/dtic/tr/fulltext/u2/a281968.pdf.

Mondo, Capt. Francis J. "Analysis of Air Force Civil Engineering Strategic Planning." Thesis, AFIT, Air University, Maxwell AFB, Alabama, 2003.

Lauson, Capt. Gary B. "Civil Engineering Combat Experiences during the Vietnam War: An Exploratory Study." Thesis, AFIT, WPAFB, Ohio, 1989.

Loeber, MSgt. Paul C. "An Investigation of GeoBase Mission Data Set Design, Implementation, and Usage within Air Force Civil Engineer Electrical and Utilities Work Centers." Thesis, AFIT, Wright-Patterson AFB, Ohio, 2005.

O'Boyle, Maj. Shannon E. "Today's Air Expeditionary Force: A Time for Change." Research report, Air Command and Staff College, Air University, Maxwell AFB, Alabama, April 2007.

Pope, Capt. Andrew D. "The Military Construction (MILCON) Program and Privatization: A Comparative Analysis." Thesis, AFIT, Wright Patterson AFB, September 1990.

Smith, Lt. Col. Emmitt G. "Air Force Engineer Squadrons: Shifting Sands or Solid Foundation." Research report, Air War College, Air University, Maxwell AFB, Alabama, 1996.

Smith, Ronald L. "Organizing Air Force Civil Engineers For Peace, War, and Military Operations Other Than War (MOOTW)." Research Report, Air War College, Maxwell AFB, Alabama, 1996.

Tyley, Major Jeffrey L. *Project Turnkey Construction of Tuy Hoa Air Base, South Vietnam – A Historical Perspective – Is There Future Application?* Air Command and Staff College, Air University, Maxwell AFB, Alabama, April 1987.

Waggoner, Capt. L. Dean and 1st Lt. M. Allen Moe. "A History of Air Force Civil Engineering Wartime and Contingency Problems from 1941 to the Present." Thesis 85S-23, AFIT, Wright-Patterson AFB, Ohio, September 1985.

Articles

"$10B AFCAP III Program Contract Provides 'Expeditionary Engineering.'" *Defense Industry Daily* (DID), 10 November 2005. http://www.defenseindustrydaily.com/10b-afcap-iii-program-contract-provides-expeditionary-engineering.

18th Wing Public Affairs. "Kadena Wins CINC's Installation Excellence Award for PACAF." 9 October 2010. http://www.kadena.af.mil/news/story.asp?id=123225820.

Air Reserve Forces Review Magazine. Washington D.C.: Department of the Air Force (November 1951).

Air Reserve Forces Review Magazine. Washington D.C.: Department of the Air Force (November 1972).

Albert, Lt. Col. Joseph L., and Capt. Billy C. Wylie. "Air War in Korea: IV Problems of Airfield Construction in Korea." *Air University Quarterly Review* Vol 5, No 1 (Winter 1951-1952).

"Amchitka Airstrip Built in 20 Days..." *Aviation Engineer Notes* No 15 (September 1943).

"American Engineers Rush Bomber Bases in England." *Aviation Engineer Notes* No 8 (August 1942).

Anderson, Maj. Jon. "Tallil Services and CE Troops Help Make Expeditionary Life Less 'Expeditionary,'" *The Tallil Times*, Vol 1, No 3, 30 May 2003. http://kumite.com/wp-content/uploads/2009/01/20030530-tallil-times-newspaper.pdf.

"An Engineer Job in the Aleutian Islands." *Aviation Engineer Notes* No 14 (August 1943).

Arna-Barradas, Louis. "Aviano Undergoes Renaissance." *Airman Magazine* (November 2000). www.af.mil/news/story.asp?id=123069313.

"The Aviation Engineers in North Africa." *Aviation Engineer Notes* No 14 (August 1943).

"Aviation Engineers on Saipan." *Aviation Engineer Notes* No 32 (February 1945).

Baldwin, William C. "Engineers and the Berlin Airlift, 1948-1949." *Engineer* (April 1998).

———. "Wherry and Capehart: Army Family Housing Privatization Programs in the 1950s." *Engineer* (April 1996).

Bentley, David. "Operation Sea Signal: U.S. Military Support for Caribbean Migration Emergencies May 1994 to February 1996." National Defense University, Strategic Forum Institute for Strategic Studies, No 3, May 1996. http://www.dtic.mil/cgi-bin/GetTRDoc?Location=U2&doc=GetTRDoc.pdf&AD=ADA394323.

Boehm, Airman 1st Class Allison M. "RED HORSE Builds up for Drawdown." *USAF Print News*, 6 April 2010. http://www.332aew.afcent.af.mil/news/story_print.asp?id=123198410.

Bowie, Christopher J. "The Lessons of Salty Demo." *Air Force Magazine* (March 2009). http://www.airforce-magazine.com/MagazineArchive/Pages/2009/March%202009/0309salty.aspx.

Brantey-Sisk, Airman 1st Class Brigitte N. "EOD Team Trains with New Response Vehicle." 20 October 2010. http://www.af.mil/news/story.asp?id=123227056.

Broshear, Capt. Nathan D. "Airmen Rediscover RED HORSE Legacy in Haiti." 22 February 2010. http://www.acc.af.mil/news/story.asp?id=123190902.

Buckingham, Maj. William A., Jr. "Operation Ranch Hand: Herbicides In Southwest Asia." *Air University Review* (July-August 1983). http://www.airpower.maxwell.af.mil/airchronicles/aureview/1983/Jul-Aug/buckingham.html.

"C-23 crashes in Georgia, 21 dead." St. Augustine, Florida (AFPN). 4 March 2001. Files of AFCEC History Office, Tyndall AFB, Florida.

Caples, Maj. W. G. "Airfield Construction on Leyte." *Aviation Engineer Notes* No 33 (March 1945).

"Civil Engineers Build Partnership Capacity in Afghanistan." *The Engineer's Compass* Vol 1, No 2 (October 2008).

"CE Rotates to El Salvador 'for the children.'" *On-Final*. 507th Air Refueling Wing, Tinker AFB, Oklahoma, July 2005 Vol 25, No 7. http://www.507arw.afrc.af.mil/shared/media/document/AFD-051221-022.pdf.

"Commendation of Aviation Engineers." *Aviation Engineer Notes* No 5 (April 1942).

Correll, John T. "How the Air Force Got the ICBM." *Air Force Magazine* (July 2005).

Correll, John T. "New Horizons for the Total Force." *Air Force Magazine* (August 2002).

"Criteria for Dispersed Airdromes." *Aviation Engineer Notes* No 8 (August 1942) and No 14 (August 1943).

Danielson, Brig. Gen. W. A. "Wings Over Panama: A Defense Airfield in Panama's Jungle." *Quartermaster Review* (July-August 1941).

Doemer, William R. and Anastasia Toutexis. "Space: New Pad for the Space Shuttle." *Time*, 5 March 1984. http://www.time.com/time/magazine/article/0,9171,952355,00.html.

Driskill, Capt. Jonathan. "36th CES Getting the Job Done." *Bitburg Skyblazer*. October 1991.

Edwards, 2nd Lt. Joshua S. "Peacekeeper Missile Mission Ends During Ceremony." *USAF Print News*, 20 September 2005. http://www.af.mil/news/story.asp?storyid=123011845.

"EOD Evolves with Fight." *Air Force Magazine* (3 April 2007). http://www.airforce-magazine.com/DRArchive/Pages/2007/April%202007/April%2013%202007/1090EOD.aspx.

"Fall and Winter Airfield Construction in France." *Aviation Engineer Notes* No 34 (April 1945).

"Field Airdrome Construction by the 807th Engineer Aviation Battalion." *Aviation Engineer Notes* No 21 (March 1944).

"First All-American Runway in the Ryukyus Islands." *Aviation Engineer Notes* No 40 (October 1945).

"Force Restructuring, Secretary Rice Remarks to Air Force Association." *HQ Air Force News Center*, 20 September 1991. Files of AFCEC History Office, Tyndall AFB, Florida.

"Force Shaping – Explaining the Numbers." *Roll Call*, 12-16 January 2007. http://www.af.mil/shared/media/document/AFD-070112-002.pdf

Frank, George J. "Bien Hoa Holocaust." *Aerospace Historian* No 27 (September 1980).

Frazier, Capt. Everette. "Airfield Reconnaissance in New Guinea." *Aviation Engineer Notes* No 33 (March 1945).

Gettle, MSgt. Mitch. "Air Force Releases New Mission Statement." *Air Force Print News Today*, 8 December 2005. http://www.af.mil/news/story_print.asp?id-123013440.

Ginovsky, John. "Air Force Looks to Alternate Sources for Light, Heat." *AF Times* (10 December 1985).

Godfrey, Brig. Gen. Stuart. "Glider-Borne Engineers." *Aviation Engineer Notes* No 24 (June 1944).

Goldsworthy, Harry E. "ICBM Site Activation." *Aerospace Historian* (Fall, September 1982).

Graham, CMSgt. Vickie M. "Interview: Gary Vest." *Airman* (April 1992).

———. "A Little Big Deal." *Airman* (April 1992).

Grant, Rebecca. *The War of 9/11*. Air Force Association Special Report, February 2005.

Grier, Peter. "The RED HORSE Way." *Air Force Magazine* (February 2003).

Gross, Dr. Charles J. "The Air National Guard Past, Present, and Future Prospects." *Airpower Journal* (Winter 1996). http://www.airpower.maxwell.af.mil/airchronicles/apj/apj96/win96/gross.html.

"Hail the 'Air Force Civil Engineer' – Farewell to the Beacon." *Civil Engineering Beacon* (November-December 1959).

Harris, Kent. "Air Force Makes Progress." *Stars and Stripes*, 30 April 2004. http://www.stripes.com/news/aviano-will-be-humming-with-more-construction-1.19409.

———. "Aviano Will be Humming with More Construction." *Stars and Stripes*, 30 April 2004. http://www.stripes.com/news/aviano-will-be-humming-with-more-construction-1.19409.

———. "Newer Buildings Replacing Plywood Huts at Bagram." *Stars and Stripes*, 31 May 2008. http://www.stripes.com/news/newer-buildings-replacing-plywood-huts-at-bagram-1.79513.

Hartzer, Ronald B. "Validating Air Force Civil Engineering Combat Support Doctrine in the Gulf War." *Air Power Journal* (Summer 1994).

Hasinger, Senior Airman Lauren. "Air Force Says farewell to most powerful ICBM." http://www.af.mil/news/story.asp?storyID=123011829.

Haulman, Dr. Daniel L. "Footholds for the Fighting Force." *Air Force Magazine* (February 2006).

———. "USAF Combat Airfields in Korea and Vietnam." *Air Power History*. (Winter 2006).

Hautz, Warrant Officer William C. "The Airborne Mission." *Aviation Engineer Notes* No 15 (September 1943).

Hebert, Adam J. "Adventures in Bare Bones Basing." *Air Force Magazine* (October 2003).

———. "Homeland and Air Force." *Air Force Magazine* (January 2004).

———. "The ICBM Makeover." *Air Force Magazine* (October 2005).

———. “Noble Eagle Without End.” *Air Force Magazine* (February 2005).

Hemingway, Ernest. “How 100,000 Chinese Built an Airport.” *Aviation Engineer Notes* No 8 (August 1942).

Hendren, John. “Beddown in Bishkek.” *Air Force Magazine* (July 2002).

“Highway Landing Strips Proposed Directive.” *Aviation Engineer Notes* No 8 (August 1942).

Howley, Lt. Col. Shawn P. and Maj. Charles R. McGinnis. “Joint Engineer Operations Course: A Combined Approach.” *Engineer, the Professional Bulletin of Army Engineers, Headquarters Department of the Army*. U.S. Army Engineer School, Fort Leonard Wood, Missouri, Vol 41, PB 5-11-1. http://www.wood.army.mil/engrmag/PDFs%20for%20Jan-Apr%2011/Howley.pdf.

Hunt, Maj. John A. “Construction of Hickam Field.” *Quartermaster Review* (November-December 1940).

Katzaman, Sr. MSgt. Jim. “Secretary of Defense Issues Khobar Towers Findings.” *Air Force News Service*, 1 August 1997. http://www.au.af.mil/au/awc/awcgate/khobar/n19970801_970946.htm.

Kim, 1st Lt. John. “577 Expeditionary Prime BEEF Group Enhance U.S. Forces-Afghanistan Installation Support.” *USAF Print News*, 28 December 2010.

King, Rachel M. (formerly Rachel M. Walkenbach) and Dwayne E. Boeres. “JEOC, Joint Engineer Operations Course.” *Engineer, the Professional Bulletin of Army Engineers, Headquarters Department of the Army*. U.S. Army Engineer School, Fort Leonard Wood, Missouri, Vol 38, PB 5-09-1. http://www.wood.army.mil/engrmag/PDFs%20for%20Jan-Apr%2009/King.pdf.

Kreisher, Otto. “Thunder Road on the Southern Flank.” *Air Force Magazine* (September 2002).

Larlee, SSgt. Jeremy. “Providing Shelter is a BEAR.” *Air Force News* (22 January 2008). http://www.af.mil/nmews/story_pring.asp?id=123083107.

Lopez, SSgt. C. Todd. “Air Force Improving Production with Smart Operations 21.” *Air Force Print News Today*, 9 January 2006. http://www.af.mil/news/story_print.asp?id-123013978.

Lopez, SSgt. C. Todd. “Smart Operations 21 Office Formed at Pentagon.” *Air Force Print News Today*, 9 January 2006. http://www.af.mil/news/story_print.asp?id-123020236.

McConnaughey, Lt. Robert S. “Salvage at Eglin Field.” *Quartermaster Review* (Jul-Aug 1944).Magaldi, Maj. Debbie. “203rd RED HORSE Dedicates Memorial to Fallen Airmen.” Virginia National Guard, 14 March 2002. http://vko.va.ngb.army.mil.

Marion, Forrest L. “Building USAF ‘Expeditionary Bases’ for Operation Enduring Freedom – Afghanistan, 2001-2002.” *Air & Space Power Journal*, Chronicles Online Journal (18 November 2005). www.airpower.au.af.mil/airchronicles/cc/marion.html.

Martinez, SSgt. Rachel. “Civil Engineer Crews Improve Bagram Infrastructure.” *USAF Print News*, 12 December 2008. http://www.af.mil/news/story.asp?id=123127806.

Menegay, Sgt. Chad. “All American Square Accommodates PAX Overflow.” *Expeditionary Times* Vol 4, No 10 (July 2010). http://www.hood.army.mil/13sce/news/sunburst/exptimes/et100721.pdf.

“New NATO Air Base Project Causes Controversy.” *Washington Post*, 10 June 1990. http://articles.dailypress.com/1990-06-10/news/9006100051_1_air-base-military-families-base-construction.

“Notes on the Carolina Maneuvers.” *Notes on Aviation Engineers*. Air Force Combat Command Engineer Section, Bolling Field, Washington, D.C., 6 February 1942.

Office of Construction Branch, Army Quartermaster Corps. “Army Construction.” *Quartermaster Review* (July-August 1937).

Perrien, MSgt. Don. “Bigger & Better, 407th ECES Builds Tallil Air Base from Barren Landscape to Busy City.” *The Tallil Times* Vol 1, No 12 (1 August 2003). http://kumite.com/wp-content/uploads/2009/01/20030801-tallil-times-newspaper.pdf.

Perrien, MSgt. Don. “Tent City Floor Project Begins.” *The Tallil Times* Vol 1, No 18 (12 September 2003). http://kumite.com/wp-content/uploads/2009/01/20030912-tallil-times-newspaper.pdf.

Philip, Airman 1st Class Kara. “Support, Teamwork Go Hand-in-Hand.” *The Tallil Times* Vol 1, No 23 (17 October 2003). http://kumite.com/wp-content/uploads/2009/01/20031017-tallil-times-newspaper.pdf.

“PBD 720 and Force Shaping.” *Roll Call*, 14 -21 December 2006. http://www.af.mil/shared/media/document/AFD-061218-013.pdf.

“Project Palace Blueprint.” *Air Force Times*. 19 November 1969.

Puryear, Cotton. "203rd RED HORSE Holds Memorial Service for Airmen, Soldiers Lost in Airplane Crash 10 Years Ago." Virginia National Guard, 4 March 2011. http://vko.va.ngb.army.mil/VirginiaGuard/news/mar11/203rdmemorial.html.

Reppert, Maj Leonard B. "The Installations Squadron in Korea." *Air University Quarterly Review* (Spring 1952).

Rhodes, MSgt. Phil. "An Eye on 2000." *Airman* (April 1992).

Riding, Alan. "Torrejon Journal; The F-16 Drama (Cont.): Happy Landing in Italy." *New York Times*, 6 February 1990. http://www.nytimes.com.

Rogin, Josh. "Air Force to Reduce IT Personnel." *Federal Computer Week*, 21 August 2006. http://fcw.com/articles/2006/08/21/air-force-to-reduce-it-personnel.aspx.

Ryan, Gen. Michael E. "History Behind Expeditionary Aerospace Force Concept." *Air Force News* (24 August 1998). http://www.fas.org/man/dod-101/usaf/unit/docs/n19980824_981264.html.

Scharven, Ron. "Lackland Turns to 'Windtricity' as Energy Source." *Air Force Print News* (11 October 2002). http://www.af.mil/stories/story_print.asp?storyID=101102285.

Shachtman, Noah. "Air Force General Hits Back Over 'Soft Power.'" 16 January 2009. http://www.wired.com/dangerroom/2009/01/air-force-gener/.

Shenon, Philip. "23 U.S. Troops Die in Truck Bombing in Saudi Base." *New York Times,* 26 June 1996. http://partners.nytimes.com/library/world/africa/062696binladen.html.

Shilter, TSgt. Merrie. "Air Force Pushes to have SLC-6 Ready by October." *Air Force News Service*, Kelly AFB, Texas, n.d. Files of AFCEC History Office, Tyndall AFB, Florida.

"The Sicilian Operations." *Aviation Engineer Notes* No 22 (April 1944).

Smith, MSgt. Deb. "RED HORSE Team Arrives." *The Tallil Times* Vol 1, No 7

(27 June 2003). http://www.ceratechinc.com/pdf/REDHORSE-1.pdf.

SourceWatch. "Air Force Augmentation Program." http://www.sourcewatch.org/index.php?title=Air_Force_Augmentation_Program.

Spilinek, 1st Lt. Lisa. "Renamed U.S. Military Base in Iraq Reflects Joint Status." *USAF Print News*, 17 June 2008. http://www.af.mil/news/story.asp?id=123103084/.

Stearns, Dr. Harold T. "Characteristics of Coral Deposits." *Aviation Engineer Notes* No 28 (October 1944).

Stewart, Airman 1st Class Erica. "VAFB Hot Shots Crew Helps Battle Blaze." *Air Force News* (3 October 2006). http://www.vandenberg.af.mil/news/story.asp?id=123029208.

"Story of the Airborne Aviation Engineers." *Aviation Engineer Notes* No 12 (February-March 1943).

Tirpak, John A. "Integrated Total Force." *Air Force Magazine* (March 2008).

Toner, Lt. Col. Richard J. "The Total Force Concept." *Air University Review* (November-December 1972). www.airpower.au.af.mil/airchronicles/aureview/1972/nov-dec/toner.html.

"Training Missions of Airborne Engineers." *Aviation Engineer Notes* No 15 (September 1943).

"Trimble Wins U.S. Air Force GeoBase Program Contracts." 20 January 2004. http://investor.trimble.com/releasedetail.cfm?ReleaseID=191416.

Troyer, Col. Doug. "Program Budget Decision 720, Force Shaping: Why Now?" *Air Force Print News Today*, 28 August 2007. http://www.vance.af.mil/news/story_print.asp?id=123066206.

Vest, Capt. Stacie A. Remy. "Military Housing Privatization Initiative: A Guidance Document for Wading Through the Legal Morass." *The Air Force Law Review* Vol 53 (2002).http://www.afjag.af.mil/shared/media/document/AFD-081204-025.pdf.

"Vinsol Resin Stabilization." *Aviation Engineer Notes* No 8 (August 1942).

Walkenbach, Rachel M. "Joint Engineer Operations Course Overview." *Engineer, the Professional Bulletin of Army Engineers, Headquarters Department of the Army*, U.S. Army Engineer School, Fort Leonard Wood, Missouri, Vol 38, Jan-Mar 2008, PB 5-08-1.

Weckerlein, SSgt. Julie. "RED HORSE Airmen Support Army in Southern Baghdad." *USAF Print News*, 9 July 2007. http://www.af.mil/news/story_print.asp?id=123060052.

White, James H. "Runway Arresting Barriers." *The Civil Engineer Beacon* (April-May 1959).

Wieseler, Airman Sondra M. "BEAR Goes BOB." *Air Force News* (5 August 2008). http://www.acc.af.mil/

news/story.asp?id=123109418
"Wing Talk." *Collier's* 18 December 1943.
Wilson, Thomas R. "Joint Intelligence and Uphold Democracy." *Joint Force Quarterly* (Spring 1995). http://www.dtic.mil/doctrine/jel/jfq_pubs/jfq1407.pdf.
Wolverton, Mark. "The Dew Line." American Heritage of Invention & Technology. www.americanheritage.com/articles/magazine/it/2007/4/2007_4_32.shtml.
Zachary, SSgt. Stacia. "RED HORSE Airmen Bring Combat Outpost into Fight." *USAF Print News*, 16 September 2009. http://www.centaf.af.mil/news/story.asp?id=123168015.

Government Documents

82d Training Wing History Office. "A Brief History of the 82d Training Wing and Sheppard AFB." http://www.sheppard.af.mil/shared/media/document/AFD-120424-046.pdf.
2005 Defense Base Closure and Realignment Commission Report. September 2005. http://www.brac.gov/finalreport.html.
AFCEE. "About AFCEE." http://www.afcee.af.mil/about.
AFCEE. "AFCEE's Role." http://www.afcee.af.mil/resources/housingprivatization/afceerole/index.asp.
AFCEE. "General Requirements." http://www.afcee.af.mil/resources/designandconstruction/usafdesignand-constructionawards/usafdesignexcellenceawards/index.asp.
AFCEE. "Organizational Chart." http://www.afcee.af.mil/about/organizationalchart/index.asp.
AFCEE. "Pollution Prevention Opportunity Assessments." May 2005. http://www.afcee.af.mil/shared/media/document/AFD-070924-152.pdf.
AFCEE. "U.S. Air Force Housing Privatization." http://www.afcee.af.mil/resources/housingprivatization/index.asp
AFCEE. "U.S. Air Force Installation Pollution Prevention Program Guide and Sample Pollution Prevention Management Action Plan." HQ AFCEE/EP, July 1996.
AFCESA. "Engineering Agile Combat Support Worldwide, 2010-2011." http://www.afcesa.af.mil/shared/media/document/AFD-101006-082.pdf.
Air Force Engineering and Services Center. "Air Force Installation Restoration Program Management Guidance." July 1985. Files of AFCEC History Office, Tyndall AFB, Florida.
Air Force Engineering and Services Center. "Zonal Maintenance Guide." Tyndall AFB, Florida, HQ AFESC, 1990.
"Air Force Facility Energy Plan FY76-85." Vol II, 1 July 1979. Files of AFCEC History Office, Tyndall AFB, Florida.
AFIT. "The Civil Engineer School at the Air Force Institute of Technology, History." AFIT. http://www.afit.edu/cess/history.cfm?tab=1.
AFIT. "Civil Engineer & Services School." AFIT. http://www.afit.edu/cess/History.cfm.
AFIT. "AFIT History." AFIT. http://www.afit.edu/about.cfm?a=history
Air Force Civil Engineer Strategic Communications, Communication Guidance Cards," 14 Feb 2012, Files of AFCEC History Office, Tyndall AFB, Florida.
Air Force Civil Engineer Strategic Communications, Air Force Civil Engineering Fact Sheets, Nov 2011, Files of AFCEC History Office, Tyndall AFB, Florida.
Air Force Tiger Team. *Airfield Obstruction Reduction Initiative Report*, 27 November 2000. http://www.afcesa.af.mil/shared/media/document/AFD-070627-103.pdf.
Air University. *Legislative History of the AAF and USAF 1941-1951*. U.S. Air Force Historical Studies, No. 84. U.S. Air Force Historical Division, Research Studies Institute, Maxwell AFB, Alabama, 1955.
Annual Histories, Air Force Civil Engineering Center, Air Force Engineering and Services Center, Air Force Civil Engineer Support Agency, Air Force Civil Engineer Center, 1972-Present.
Annual Histories, Air Staff Director of Installations, Director of Civil Engineering, Director of Engineering

and Services, Office of The Civil Engineer, 1949-Present.

Arnold Engineering Development Center. “2008 Test Facility Guide, Test Before Flight.” 2008.

August, Jean, Herbert P. Carlin, William Elliott, Kathi R. Jones, Carol H. Parks, Layne B. Peiffer, William W. Suit, and John D. Webber. “History of the Air Force Materiel Command 1 October 1993-30 September 1994.” Volume XVII: Supporting Documents F-1—F-60, Office of the Command Historian, HQ Air Force Materiel Command, Wright-Patterson AFB, Ohio.

Aviation Engineers in Mobile Warfare, IX Engineer Command. IX Engineer Command, 1945. http://www.ixengineercommand.com/units/ixec/mobile-warfare/Index.php.

Baldwin, William C. “Army Engineers in Post-War Reconstruction: The Philippines, Japan, and Germany, 1945-1947.” Office of History, HQ U.S. Army Corps of Engineers, n.d.

“Bare Base Development Program Project 3782, Corona Harvest.” 24 January 1969. Air Mobility Division, Deputy for Limited War, Aeronautical Systems Division. Muir S. Fairchild Research Information Center, Maxwell AFB, Alabama.

Bayer, Robert E. “Military Housing Privatization Initiative by Robert E. Bayer Deputy Assistant Secretary of Defense (Installations) March 7 1996, Before the Subcommittee on Military Installations and Facility of the House Committee on National Security.” http://www.acq.osd.mil/housing/ct97_bayer.htm.

Beerman, Timothy. United State Air Force Academy GeoBase Program, ca. 2004. http://proceedings.esri.com/library/userconf/proc04/docs/pap1306.pdf.

Brown, CMSgt. Dave, CMSgt. (Retired) Marshall B. “Doc” Dutton, and SMGt. Marshall G. “Baby Doc” Dutton. “Air Force EOD’s Move, USAF Exploded Ordnance Disposal (EOD), From Maintenance to Civil Engineering.” n.d. Files of AFCEC History Office, Tyndall AFB, Florida.

Brown, Ronald J. *Humanitarian Operations in Northern Iraq, 1991: With Marines in Operation Provide Comfort*. History and Museums Division HQ, U.S. Marine Corps, Washington, D.C., 1995.

Butler, William M. and Lt. Col. Glen W. Moorhead III. “History of Headquarters Sixteenth Air Force 1 January 2003-31 December 2003 Assigned to United States Air Forces in Europe Stationed at Aviano Air Base, Italy.” 26 January 2005. Files of Air Force Historical Research Agency, Maxwell AFB, Alabama.

Byers, Maj. Gen. Timothy A., CEnterline Video Script, “CE Transformation Update,” 4 June 2012, Files of AFCEC History Office, Tyndall AFB, Florida.

Byers, Maj. Gen. Timothy A., “Keynote Speech, AFCEC Activation Ceremony,” 1 Oct 2012, Files of the AFCEC History Office, Tyndall AFB, Florida.

Cheatham, Col. Daniel W., Jr. “Implementation of Military Aircraft Noise Standards.” Department of the Air Force, Air Force Aero Propulsion Laboratory, Wright-Patterson AFB, Ohio, 17 July 1974. Files of AFCEC History Office, Tyndall AFB, Florida.

Clark, Maj. James I. “Project Touchdown: A Comprehensive Evaluation of the Northrup Strip Airfield, White Sands Missile Range, as a Landing Site for the Space Shuttle Orbiter.” Prepared for National Aeronautics and Space Administration, July 1979.

Cohen, William S. “Chapter 8: Total Force Integration.” *Annual Report to the President and the Congress*, 1998. http://www.defenselink.mil/execsec/adr1999/chap8.html.

Collin, Mr. H., Col. G. Ellis, Lt. Col. R. Hamel, Mr. L. Henriksen, and Lt. Col. W. Sims. “Blue Print for Base Planning and Management Actions Book Two, AAF BMAG.” April 1976. Files of AFCEC History Office, Tyndall AFB, Florida.

Conn, Stetson, Rose Engelman, and Byron Fairchild. *Guarding the United States and Its Outposts*. Washington, D.C.: Center of Military History, 2000.

Continental Air Command. “Air Installations.” Manual 50-10 Vol 1 (January 1952). Files of AFCEC History Office, Tyndall AFB, Florida.

De Blonk, Capt. David M. and Col. Robert G. Gardner. “A HQ USAF Directorate of Civil Engineering (AFOCE) Activity Input to Project Corona Harvest on Civil Engineering Support in SEA 1 January 1965 – 31 March 1968.” Submitted 18 December 1969 by the U.S. Air Force, Civil Engineering Center. Files of AFCEC History Office, Tyndall AFB, Florida.

“Defense Reform Initiative Directive # 9 – Privatizing Utility Systems.” 10 December 1997. http://www.

defense.gov/dodreform/drids.htm.

"Defense Reform Initiative Directive # 36 – Disposal/Demolition of Excess Structures." 5 May 1998. http://www.defense.gov/dodreform/drids.htm.

"Defense Reform Initiative Directive # 49 – Privatizing Utility Systems." 23 December 1998. http://www.defense.gov/dodreform/drids.htm.

Department of the Air Force Environmental Statement on the Disposition of Orange Herbicide by Incineration. National Agricultural Library Special Collections. Alvin L. Young Collection on Agent Orange, November 1974. www.nal.usda.gov/speccoll/findaids/agentorange.

"Engineering Lessons Learned in Southeast Asia 1964-1969." PACAF Civil Engineering, Preliminary Report 12 June 1969. Files of AFCEC History Office, Tyndall AFB, Florida.

ESRI. "GIS in Defense Installation and Environmental Management." 2007. http://www.esri.com/library/brochures/pdfs/gis-in-defense-installation.pdf.

"FEAF Korean War Report: SCARWAF Engineering Aviation Units—Our Chosen Construction Forces." Air Force Historical Research Agency, Maxwell AFB, Alabama, n.d. Files of AFCEC History Office, Tyndall AFB, Florida.

Formal Report of the Civil Engineering Manpower Study Group (Project Prime Beef). 1964. Files of AFCEC History Office, Tyndall AFB, Florida.

"Global Engagement: A Vision for the 21st Century Air Force." http://www.au.af.mil/au/awc/awcgate/global/nuvis.htm.

Goodman, John B. "Statement of John B. Goodman Deputy Under Secretary of Defense." http://www.dod.gov/dodgc/olc/docs/test97-3-13Goodman.htm.

Greacen, Lt. Col. Thomas E., II. "The Buildings and Grounds Office of the Army Air Corps, 1918-1944." AFHRA No 00117504. Files of AFCEC History Office, Tyndall AFB, Florida.

Hanley, Timothy C. and Harry N Waldron. "Historical Overview Space and Missile Systems Center, 1954-1995." http://www.fas.org/spp/military/program/smc_hist/index.html.

Hartzer, Dr. Ronald B., "Gulf War History," n.d., Files of AFCEC History Office, Tyndall AFB, Florida.

Haulman, Dr. Daniel L. "Air Force Humanitarian Airlift Operations 1991-2000." 21 January 2010. http://www.afhra.af.mil/shared/media/document/AFD-100125-098.pdf.

HQ AFESC. "Final Report on Project Touchdown: A Comprehensive Evaluation of Northrup Strip Airfield, White Sands Missile Range, As a Landing Site for the Space Shuttle Orbiter." Prepared for National Aeronautics and Space Administration, February 1981.

HQ Strategic Air Command. *SAC Missile Chronology 1939-1988*. Office of the Historian, HQ Strategic Air Command, Offutt AFB, 1988.

HQ USAF, Program Action Directive (PAD) 12-03, "Implementation of Enterprise-Wide Civil Engineer Transformation," 26 Oct 12.

HQ First Air Force. *Arms and Services, February 1941 to December 1944*. Vol I, Chapter IV, "Engineer Training." Maxwell AFB, Alabama: Air Force Historical Research Agency, August 1946.

Hill, James A., Lt. Gen. "Air Installation Compatible Use Zone (AICUZ) – policy." HQ U.S. Air Force, Washington D.C., 17 December 1974.

"*History of the Aviation Engineers in the Mediterranean Theater of Operations*." Historical Section, AAF Engineer Command, MTO, (12 June 46).

Howe, Brig. Gen. Dave, CEnterline Video Script "CE Transformation Supplemental Video: MAJCOM CE Staff of the Future," 31 July 2012.

Howes, Merwin H. "Methods and Costs of Constructing the Underground Facility of North American Air Defense Command at Cheyenne Mountain, El Paso County, Colorado." Information circular 8294. U.S. Department of the Interior, Bureau of Mines, 1966.

Huffman, Arlie C. "Development of the Air Force Civil Engineering Function, 1918—Present." Directorate of Civil Engineering, May 1962. Files of AFCEC History Office, Tyndall AFB, Florida.

"In-Depth Review of the San Antonio Real Property Maintenance Agency (SARPMA): Prepared at the request of the Vice Chief of Staff of the United States Air Force." Programs and Long Range Planning

Directorate, DCS Plans, Air Training Command. November 1983. Files of AFCEC History Office, Tyndall AFB, Florida.

Institute of Medicine. *Veterans and Agent Orange: Health Effects of Herbicides Used in Vietnam.* Committee to Review the Health Effects in Vietnam Veterans of Exposure to Herbicides, Division of Health Promotion & Disease Prevention. Washington, D.C.: National Academy Press, 1994.

Joint Chiefs of Staff. *Joint Engineer Operations*, Joint Publication 3-34. 2007. http://www.bits.de/NRANEU/others/jp-doctrine/jp3_34(07).pdf.

Joint POW/MIA Accounting Command. "JPAC Mission Overview." http://www.jpac.pacom.mil/index.php?page=mission_overview.

Lavin, Mary K. "Thematic Study and Guidelines: Identification and Evaluation of U.S. Army Cold War Era Military-Industrial Historic Properties." Prepared by Horne Engineering & Associates. Prepared for U.S. Army Environmental Center, Aberdeen Proving Ground, Maryland, 1997.

"Lineages and Honors." Files of Air Force Historical Research Agency, Maxwell AFB, Alabama.

McAndrews, John A., ed. *Air Force Contribution to U.S. Public Works*. Study No. 143, 1974. Files of Air Force Historical Research Agency, Maxwell AFB, Alabama.

McCracken, Portia R. "Bird Strikes and the Air Force." Wildlife Damage Management, Internet Center for Bird Control Seminars Proceedings, University of Nebraska, 1976. http://digitalcommons.unl.edu/icwdm-birdcontrol/53/

Manning, Thomas A., Dr. Bruce A. Ashcroft, Richard E. Emmons, Ann K. Hussey, and Dr. Joseph L. Mason. *History of Air Education and Training Command 1942-2002*. Office of History and Research HQ, Air Education and Training Command, Randolph AFB, Texas, 2005. http://www.aetc.af.mil/shared/media/document/AFD-061109-022.pdf.

Martin, Jean, SSgt. Douglas W. Stephens, and SSgt. Robert F. Jakob. *USAF Airfield Construction in South Vietnam July 1965 – March 1967*. Historical Division Directorate of Information, HQ 7th AF, n.d.

Merritt, Maj. Ronald L. "US Air Force Bird Aircraft Strike Hazard (BASH): Summary Report for 1993." Files of AFCEC History Office, Tyndall AFB, Florida.

National Museum of Health & Medicine. "Exhibit Featuring Emergency Room from Air Force Hospital in Balad, Iraq Opens at National Museum of Health & Medicine." 25 November 2008. http://www.nmhm.washingtondc.museum/news/AF_hospital_balad.html.

National Museum of the U.S. Air Force. http://www.nationalmuseum.af.mil/index.asp.

National Park Service. "Tuskegee Airmen Civilian Pilot Training." www.cr.nps.gov/museum/exhibits/tuskegee/airtrain.htm.

Neufeld, David. "BAR-1 Distant Early Warning (DEW) Line Auxiliary Station Komakuk Beach, Yukon Territory." Agenda Paper, 1992. Files of AFCEC History Office, Tyndall AFB, Florida.

Neufeld, David. "Implementing Parks Canada's Cultural Resource Management Policy, Commemorating the Cold War in Canada: Considering the DEW Line." 1998. Files of AFCEC History Office, Tyndall AFB, Florida.

New Mexico Engineering Research Institute. *Lessons Learned by Civil Engineering, Services, Air Base Operability, Disaster Preparedness, and Explosive Ordnance Disposal during Desert Shield/Desert Storm Proven Force/Provide Comfort*. Prepared for Deputy Chief of Staff for Civil Engineering HQ, Air Combat Command and HQ Air Force Civil Engineering Support Agency, 1992.

Nixon, Richard. Executive Order No. 11593 Protection and Enhancement of the Cultural Environment. 15 May 1971.

North American Aerospace Defense Command and U.S. Space Command. "The Cheyenne Story." ca. 1995. Files of AFCEC History Office, Tyndall AFB, Florida.

Office of the Assistant Secretary of Defense. "News Release No. 202-99." 27 April 1999. http://www.defense.gov/releases/release.aspx?releaseid=2070.

"Organization and Functions of Engineers in Autonomous AF." n.d., ca. May 1947.

Peer, Eugene E. "History of the Civil Engineering School." November 1976 manuscript. Files of AFCEC History Office, Tyndall AFB, Florida.

Peters, F. Whitten and Gen. Michael E. Ryan. "Press Briefing Regarding Air Expeditionary Forces." U.S. Department of Defense, 4 August 1998.

Poad, Col. William J. "Noise Exposure Forecast (NEF) Implementation." Department of the Air Force, HQ U.S. Air Force, Washington D.C., 31 October 1973.

"Readiness Management Support (RMS), L.C., Operation Sustain Hope, Camp Hope, Camp Eagle and Camp Liberty, Republic of Albania, Project History and Final Report." Prepared for HQ U.S. Air Force Europe, Civil Engineering, 27 July 1999. Files of AFCEC History Office, Tyndall AFB, Florida.

"Readiness and Ownership Oriented Management (ROOM)." Strategic Air Command. n.d. Files of AFCEC History Office, Tyndall AFB, Florida.

Rhodes, Albert N. "Herbicide Orange Monitoring Program Addendum I, January 1980 – February 1985." Engineering & Services Laboratory, Air Force Engineering & Services Center, Tyndall AFB, Florida, May 1985. National Agricultural Library Special Collections, Alvin L. Young Collection on Agent Orange. www.nal.usda.gov/speccoll/findaids/agentorange/index.htm.

Rice, Donald B. "Global Reach Global Power: The Evolving Air Force Contribution to National Security." Air Force White Paper prepared by the Department of the Air Force, December 1992. Muir S. Fairchild Research Information Center, Maxwell AFB, Alabama.

Ruschmann, Lt. Col. "Air Force Engineering and Services Participation in OPERATION DESERT SHIELD from a TAC Engineering and Services Readiness Planners Perspective." Files of AFCEC History Office, Tyndall AFB, Florida.

Sheridan, CMSgt. Richard. "49th Materiel Maintenance Group BEAR." Presentation, 13 January 2009. http://same-satx.org/briefs/090113-sheridan.pdf.

Smith, Pamela W. "Agent Orange: Veterans' Complaints Concerning Exposure to Herbicides in South Vietnam Issue Brief Number IBS0040." National Agricultural Library Special Collections. Alvin L. Young Collection on Agent Orange, Science Policy Research Division, September 6 1979. www.nal.usda.gov/speccoll/findaids/agentorange.

"Special Projects of I Troop Carrier Command, Part I: The Training of Airborne Engineer Aviation Battalions Within I Troop Carrier Command." HQ IX Troop Carrier Command, November 1945.

Tetra Tech Inc. *U.S. Air Force Energy Plan 1978*. Prepared for Chief of Staff, U.S. Air Force. July 1978. Files of AFCEC History Office, Tyndall AFB, Florida.

U.S. Air Force. *The Air Force Smart Operations for the 21st Century CONOPS and Implementation Plan*, Draft. 7 February 2006.

U.S. Air Force. *The Air Force Smart Operations for the 21st Century Playbook*. May 2008.

U.S. Air Force. *Concept of Operations For Fire Prevention and Consequence Management*. Tyndall AFB, Florida: HQ AFCESA/CEXF. 15 June 2007.

U.S. Air Force. *Engineer Squadron Reorganization Implementation Plan,* Program Action Directive 07-02, Implementation of the Civil Engineer (CE) Transformation Plan. HQ AFCESA, Tyndall AFB, Florida. 15 November 2007.

"USAF GeoBase Program Goals and Future Direction." Presentation at HQ U.S. Air Force, May 2007. http://proceedings.ndia.org/jsem2007/Cray.pdf.

U.S. Air Force. Historical Brochure of SEA Engineering Development 1961-1965. Prepared by Directorate of Civil Engineering, PACAF. Muir S. Fairchild Research Information Center, Maxwell AFB, Alabama.

U.S. Air Force. "History Milestones." 31 December 1999. http://www.af.mil/information/heritage/milestones.asp?dec=1990&sd=01/01/1990&ed=12/31/1999.

U.S. Air Force. *Implementation of Civil Engineer (CE) Transformation Plan*, U.S. Air Force, Program Action Directive 07-02. Washington, D.C.: HQ U.S. Air Force. 19 April 2007.

"USAF Logistics Activities in Support of Operations in Southeast Asia 1 January 1965 – 31 December 1969." Files of Air Force Historical Research Agency, Maxwell AFB, Alabama.

U.S. Air Force. *Military Operations Other Than War*. Air Force Doctrine Document 2-3. 3 July 2000.

U.S. Air Force. "U.S. Air Force Biographies." http://www.af.mil/information/bios

U.S. Air Forces in Europe. *Rhein-Main Transition Program Management Document*. 7 November 2003. Files

of AFCEC History Office, Tyndall AFB, Florida.
U.S. Congress. *U.S. Public Law 253*. 80th Cong., 1st sess., 26 July 1947.
U.S. Department of Defense. “Defense Department Compliance with the NHPS: Section 202 (a)(6) Evaluation Report (1994).” http://www.achp.gov/defenseexcerpt.html.
U.S. Department of Defense. *Joint Doctrine for Military Operations Other Than War*. Joint Publication 3-07. 16 June 1995.
U.S. Department of Defense. “NASA Aeronautics Facilities Critical to DoD Report to Congress.” January 2007.
U.S. Department of Defense. News Release: Air Force Reorganizes Staff Structure, No 082-06, 30 January 2006. http://www.defense.gove/releases/release.aspz?releaseid=9268.
U.S. Department of Defense. *Quadrennial Defense Review*, 30 September 2001. http://www.defense.gov/pubs/qdr2001.pdf.
U.S. Department of Defense. *Quadrennial Defense Review*, 6 February 2006. http://www.defense.gov/qdr/report/report20060203.pdf.
U.S. Department of Defense. Unified Facilities Criteria (UFC) 4-010-01, DoD Minimum Antiterrorism Standards for Buildings, 8 October 2003. http://www.wbdg.org/ccb/DOD/UFC/ufc_4_010_01.pdf.
U.S. Department of the Interior. “White House Closing the Circle Awards.” http://www.doi.gov/greening/awards/whawards.html.
U.S. Environmental Protection Agency. “The Challenge of the Environment: A Primer on EPA’s Statutory Authority.” Environmental Protection Agency. http://www.epa.gov/history/topics/fwpca/05.htm.
U.S. Environmental Protection Agency. “National Pollutant Discharge Elimination System (NPDES).” Environmental Protection Agency. http://cfpub.epa.gov/npdes/.
U.S. Environmental Protection Agency. “Origins of Modern Air Pollution Regulations.” Environmental Protection Agency. http://www.epa.gov/apti/course422/apc1.html.
U.S. Environmental Protection Agency. “Regulations for Open Dumps, Landfills, and Transfer Stations.” Environmental Protection Agency. http://www.epa.gov/region09//waste/tribal/reg.html.
U.S. Environmental Protection Agency. Transcript: Public Hearing – “Incinerate Herbicide Orange at Sea.” 7 April 1977. National Agricultural Library Special Collections, Alvin L. Young Collection on Agent Orange. www.nal.usda.gov/speccoll/findaids/agentorange.
U.S. Marine Corps Command and Staff College. *The Expeditionary Aerospace Force: Is the Air Force Really Expeditionary?* Marine Corps University, Quantico, Virginia, 2000. http://www.dtic.mil/cgi-bin/GetTRDoc?Location=U2&doc=GetTRDoc.pdf&AD=ADA515728.
Walker, Lois E. “Air Force Engineer Support to Kosovo Operations, JTF Allied Force (Operation Noble Anvil), JTF Shining Hope (Operation Sustain Hope).” AFCESA, 1999. Files of AFCEC History Office, Tyndall AFB, Florida.
Waller, Niklaas A. TSgt. A. *Fifty Years of Friendship and Cooperation A History of Aviano Air Base 1955-2005*. Office of History, HQ 31st Fighter Wing Aviano AB. 1 February 2005. http://www.af.mil/shared/media/document/AFD-070921-019.pdf.
Westover, John G. “U.S. Army In Action Series; Combat Support in Korea.” Washington D.C.: Center of Military History, U.S. Army, 1987.
Widnall, Sheila E. “Report of the Secretary of the Air Force.” 1996. http://www.dod.gov/execsec/adr96/airforce_report.html.

Misc Sources

GlobalSecurity.org. “Air Force Contract Augmentation Program (AFCAP).” http://www.globalsecurity.org/military/agency/usaf/afcap.htm.
———. “Base Realignment and Closure (BRAC).” http://www.globalsecurity.org/military/facility/brac.htm.
———. “Combined Joint Task Force – Horn of Africa.” http://www.globalsecurity.org/military/agency/dod/

cjtf-hoa.htm.

———. "Operation Joint Endeavor." http://www.globalsecurity.org/military/ops/joint_endeavor.htm.

———. "Team Spirit." www.globalsecurity.org/military/ops/team-spirit.htm.

RED HORSE Association. "RED HORSE Unit Histories." www.redhorseassociation.org.

INDEX

Leading the Way *describes how the men and women of Air Force Civil Engineering have provided the basing that enabled the Air Force to Fly, Fight, and Win. This book depicts how engineers built hundreds of bases during World Wars I and II, Korea, Vietnam, the Gulf War, and Operations ENDURING FREEDOM and IRAQI FREEDOM. At the same time, these engineers operated and maintained a global network of enduring, peacetime bases. It describes the engineers' role in special projects such as the ballistic missile program, the Arctic early warning sites, and construction of the U.S. Air Force Academy. Using hundreds of sources, this detailed narrative tells the story of how civil engineers have been organized, trained, equipped, and employed for more than 100 years. From the beaches of Normandy to the mountains of Afghanistan, civil engineers have forged an unmatched record of success and built a solid foundation for today's Air Force.*

Front Cover: Aviation engineers clearing debris on the island of Saipan take a break to pose with their equipment, 1944. (U.S. Air Force photo)
Back Cover: Airman 1st Class Joshua Toth, a heavy equipment operator with the 455th Expeditionary Civil Engineer Squadron, smooths wet concrete on Thanksgiving Day, Nov. 27, 2008, at Bagram Airfield, Afghanistan. (U.S. Air Force photo/Staff Sgt. Samuel Morse)