

REPORT DOCUMENTATION PAGE					Form Approved OMB No. 0704-0188	
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1. REPORT DATE (DD-MM-YYYY)		2. REPORT TYPE			3. DATES COVERED (From - To)	
6 May 2019		Master's of Military Studies			SEP 2018 - MAY 2019	
4. TITLE AND SUBTITLE Air Force Civil Engineer Preparation for Distributed Operations				5a. CONTRACT NUMBER		
				N/A		
				5b. GRANT NUMBER		
				N/A		
				5c. PROGRAM ELEMENT NUMBER		
				N/A		
6. AUTHOR(S) Murley, David J, Major, USAF				5d. PROJECT NUMBER		
				N/A		
				5e. TASK NUMBER		
				N/A		
				5f. WORK UNIT NUMBER		
				N/A		
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) USMC Command and Staff College Marine Corps University 2076 South Street Quantico, VA 22134-5068					8. PERFORMING ORGANIZATION REPORT NUMBER	
					N/A	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)					10. SPONSOR/MONITOR'S ACRONYM(S)	
					Dr. Craig Swanson	
					11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
					N/A	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release, distribution unlimited.						
13. SUPPLEMENTARY NOTES						
14. ABSTRACT Airpower has provided American forces with an asymmetric advantage in conventional wars since the middle of World War II. The current strategic environment presents a challenge to the accepted basing posture of the U.S. Air Force. The U.S. joint force is developing distributed basing concepts to disperse U.S. assets throughout theaters of operation to limit its risk. Skilled Air Force civil engineers may be required to open, operate, maintain, and recover distributed airfields during a major war. However, current engineer organization, training, and equipment may not be sufficient to successfully implement distributed operations. Improvements to civil engineer preparation are essential to implementing distributing basing and ena						
15. SUBJECT TERMS Air Force, civil engineer, distributed basing, training, doctrine						
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON	
a. REPORT	b. ABSTRACT	c. THIS PAGE			USMC Command and Staff College	
Unclass	Unclass	Unclass	UU	53	19b. TELEPHONE NUMBER (Include area code) (703) 784-3330 (Admin Office)	

*United States Marine Corps
Command and Staff College
Marine Corps University
2076 South Street
Marine Corps Combat Development Command
Quantico, VA 22134-5068*

**AIR FORCE CIVIL ENGINEER PREPARATION TO IMPLEMENT DISTRIBUTED
BASING OPERATIONS**

SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF MILITARY STUDIES

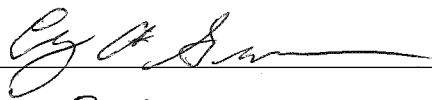
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AY 2018-2019

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EXECUTIVE SUMMARY

Title: Air Force Civil Engineer Preparation to Implement Distributed Basing Operations

Author: David Jason Murley, Major, United States Air Force

Thesis: The U.S. Air Force must change how it organizes, trains, and equips its civil engineer forces in order to successfully implement distributed operations in a conventional war with a near-peer adversary.

Discussion: Airpower has provided American forces with an asymmetric advantage in conventional wars since the middle of World War II. However, the current strategic environment and potential adversary capabilities present a challenge to accepted basing posture of the U.S. Air Force. Currently, the Air Force depends on a small number of large air bases to posture its forces. Growing adversary air and missile capabilities put these airfields at risk. The U.S. joint force is developing distributed basing concepts to disperse U.S. assets throughout theaters of operation to limit its risk. Skilled Air Force civil engineers will be required to open, operate, maintain, and recover distributed airfields during a major war. However, current engineer readiness culture, organization, training, and equipment are not sufficient to successfully implement distributed operations. Improvements to civil engineer preparation are essential to implementing distributed basing and enabling the success of American airpower.

Conclusions: Air Force civil engineer training should be examined to ensure that Airmen are proficient in the correct skillsets to implement distributed basing. Additionally, the Air Force should examine the process by which expeditionary civil engineer squadrons are resourced to ensure highly capable and integrated units are provided to theater commanders. Finally, the Air Force must rethink how civil engineers are equipped for both training and wartime tasks to ensure they possess the right equipment when they need it. The readiness culture of Air Force civil engineers must be reinvigorated to adequately address these issues.

TABLE OF CONTENTS

Illustrations	vi
Abbreviations and Acronyms	vii
Acknowledgements	viii
Introduction and Threat Background	1
Mitigation Philosophies and Programs	6
Readiness Culture	9
Organization.....	11
Training.....	21
Equip	30
Additional Thoughts	35
Conclusion	37
Notes	40
Bibliography	43

ILLUSTRATIONS

Figure 1. Chinese Improvement in Missile Range Threats U.S. Bases	3
Figure 2. Distances to the South China Sea	5
Figure 3. F-16 in front of a Hardened Aircraft Shelter at Balad Air Base, Iraq	6
Figure 4. Rapid Airfield Damage Assessment System Prototype	8
Figure 5. Engineers repair the Qayyarah West runway to enable the Mosul Offensive.....	16
Figure 6. Engineers execute rapid airfield damage repair during Exercise Resilient Shogun.....	29
Figure 7. Engineers construct an airfield in the Saharan Desert.....	31
Figure 8. Standard Equipment Assigned to an Engineer Aviation Battalion	33
Figure 9. An engineer improves an airfield near a B-29 in the Southwest Pacific.....	34
Figure 10. Paracel and Spratly Island Chains	36

ABBREVIATIONS AND ACRONYMS

AEW	Air Expeditionary Wing
AFI	Air Force Instruction
AFSC	Air Force Specialty Code
AOR	Area of Responsibility
APOD	Aerial Port of Debarkation
CENTCOM	Central Command
CEWTS	Civil Engineer Wartime Task Standards
COMAFFOR	Commander, Air Force Forces
ECEG	Expeditionary Civil Engineer Group
GPS	Global Positioning System
HAS	Hardened Aircraft Shelter
JFACC	Joint Force Air Component Commander
MEET	Mission Essential Equipment Training
Prime BEEF	Prime Base Engineer Emergency Force
RADAS	Rapid Airfield Damage Assessment System
RADBO	Recovery of Airbases Denied by Ordnance
RADR	Rapid Airfield Damage Recovery
RED HORSE	Rapid Engineer Deployable Heavy Operation Squadron, Engineer
UTC	Unit Type Code

ACKNOWLEDGEMENTS

I would like to thank my advisors, Dr. Swanson and LtCol Patrizia Dienhart-Stabile, for providing their wisdom and advise throughout the writing process. Additionally, many thanks are owed to the Air Force Civil Engineer Center Readiness Directorate at Tyndall Air Force Base for providing information and data related to expeditionary engineer training. Major Joshua Hager also dedicated significant time to edit drafts and to share his extensive deployment experience to support my research. Most importantly, I would like to thank my family for their patience and support during the writing process.

Introduction

The U.S. Air Force has long recognized the importance of air bases to its mission. Writing in 1941, Gen Henry “Hap” Arnold noted that the air base comprised “one of the three vital constituent elements of an air force, namely, flying men, flying machines, and air bases.”¹ Given this importance and a history of American aerial dominance, potential adversaries are constantly examining new methods of neutralizing American airpower by destroying air bases. In current times, potential U.S. adversaries are developing weapons to deny access to air bases in time of war through the use of a barrage of standoff weapons. The Air Force and the joint force are proposing to use advanced basing concepts such as distributed basing to counter anti-access and area denial threats in future war. Numerous technological advancements are under development to implement these new concepts, but Air Force civil engineer culture, organization, training, and equipment require improvement to successfully implement distributed basing in a high-intensity conventional conflict with a near-peer adversary. In developing these improvements, lessons from historical case studies can be applied. The Pacific Theater of World War II exhibits many similarities to today’s security environment; the lessons learned from that conflict will be applied to recommend improvements for the organization, training, and equipping of today’s Air Force civil engineers.

Background

Airpower has provided a significant asymmetric advantage for U.S. forces since the middle of World War II. It has provided tremendous advantage in many conflicts because U.S. airpower provides the capability to simultaneously strike both tactical, operational, and strategic targets

while preventing adversaries from doing the same.² The superiority of both U.S. technology and personnel have made U.S. airpower difficult to defeat, especially in the air. History has shown that air forces are often more decisively defeated when aircraft are destroyed on the ground as illustrated by the U.S. Army Air Forces' success in the Pacific Theater in 1944³ and the decisive Israeli air campaign against Egypt during the Six Days War.⁴ This has led militaries to explore better methods of defeating air forces on the ground.

Potential adversaries of the U.S. are increasing precision standoff weapon capability that can neutralize large U.S. bases in order to counter American air dominance. Precision guided cruise and ballistic missiles have posed a significant threat to airbases as early as 1999. Air base vulnerability to both cruise and ballistic missiles is well documented in the RAND study "Airbase Vulnerability to Conventional Cruise-Missile and Ballistic-Missile Attacks: Technology, Scenarios, and U.S. Air Force Responses." While missiles have been a threat since the later period of World War II, precision technology has made them more lethal in modern times. The RAND report specifically identifies GPS-guided, slow-flight cruise missiles outfitted with cluster munitions as a high risk because they avoid detection by traditional radar technology and provide a maximum damage radius. Such a missile could inflict significant damage on both aircraft parked on the ramp as well as airfield facilities necessary for sortie generation.⁵ Outside of this specific technology, there are a wide-range of existing ground and air launched weapons capable of significantly damaging or destroying airfields such as the Chinese NORINCO anti-runway cluster bomb,⁶ the Chinese DF-21 medium-range ballistic missile,⁷ and the Russian 3M-14AE cruise missile.⁸

As China continues to expand its influence and footprint in the Pacific, airfields operated by U.S. forces and its allies and partners are at increased risk of a potentially catastrophic attack. The militarization of the South China Sea and improving technology have increased the effective range of Chinese missiles and aircraft.⁹ The traditional large, consolidated airfield construct that the U.S. has relied upon since the Korean War and the relatively small U.S. aircraft inventory now present a significant liability as access to geostrategic locations is restricted and a limited number of combat aircraft are exposed to more risk as shown in Figure 1.

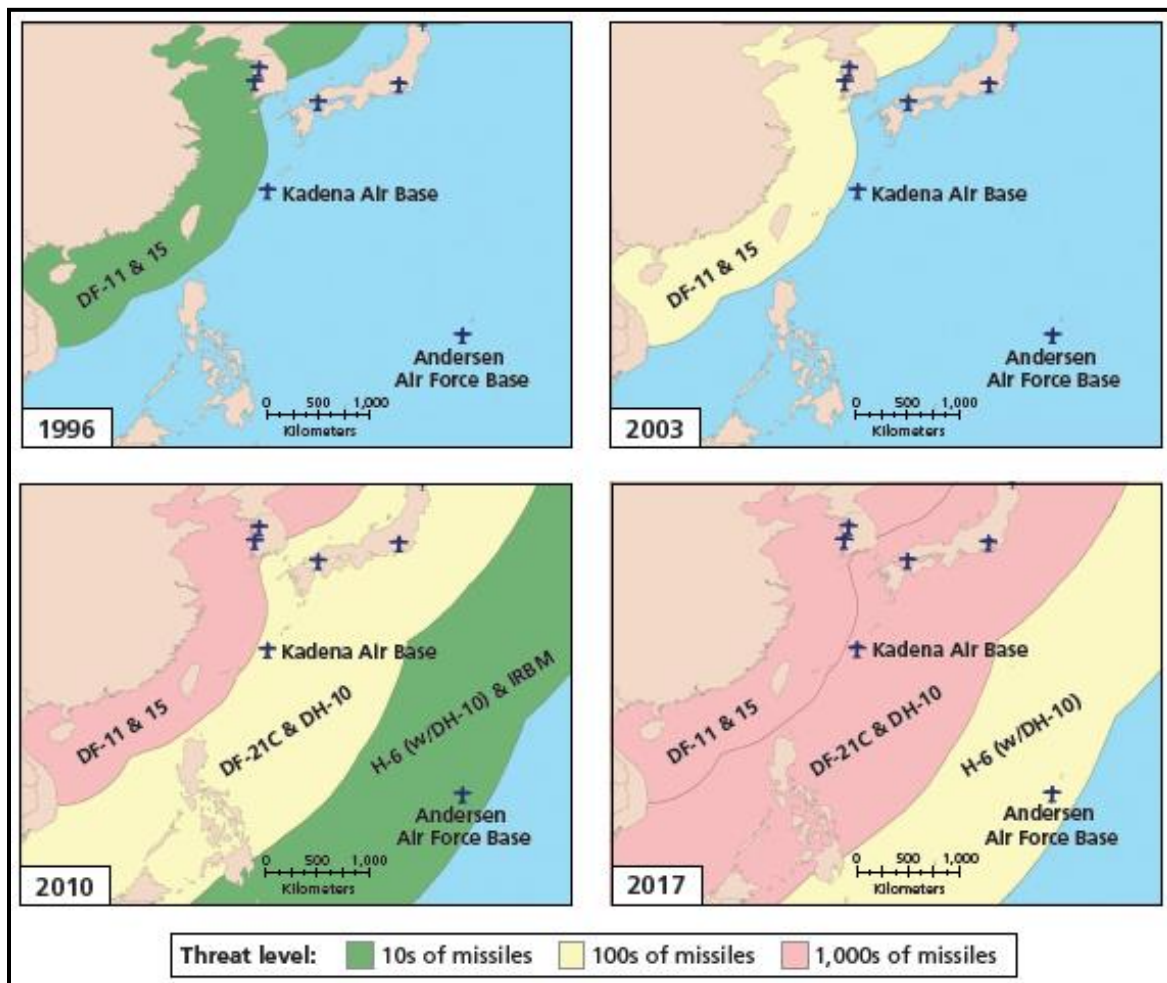


Figure 1. Chinese improvement in missile range threatens U.S. airbases.

Source: Eric Heginbotham et al, “The U.S.-China Military Scorecard: Forces, Geography, and the Evolving Balance of Power 1996-2017”, Research Brief, (Washington: RAND, 2018), 51.

The Pacific Theater in World War II presents an interesting comparison to today's operating environment because of the similar large oceanic distances, key littoral terrain, and harsh operating conditions involved in the theater campaign. General Douglas MacArthur employed a true combined arms concept to operations in the Southwest Pacific, and he relied heavily on Fifth Air Force commanded by Major General George Kenney to dominate the air and enable land and maritime operations. Air forces were typically first employed to gain air superiority by destroying enemy aircraft in the air and on the ground. Once this was accomplished, Fifth Air Force focused on isolating the battlefield to restrict the enemy from counterattacking, reinforcing, and performing supply functions in the area of operations. With the battlefield isolated, MacArthur would commit ground forces to decisively defeat the enemy; Fifth Air Force routinely provided air transport and attack aviation to aid in the ground effort. After a battlefield victory was achieved, the next objective was selected and the process would repeat.¹⁰ This concept placed a special importance on the ability of engineers to rapidly construct networks of airfields and recover them after attack; in fact, MacArthur famously stated that the war in the Southwest Pacific Theater was "an engineer's war" because of the critical contribution and unique challenges faced by engineers.¹¹

The Pacific Theater posed many of the same challenges in 1945 as it does today as the U.S. places a renewed interest in the South China Sea. The limited littoral terrain and large distances across the Pacific as shown in Figure 2 can force the use of airfields within enemy threat rings. Fifth Air Force used dispersal to counter the threats posed to its air assets by the Japanese; the dispersal effort required the construction, operation, and maintenance of numerous airfields in a relatively high-threat environment.¹² The Chinese Air Force and Chinese ballistic missile

capability cause similar problems for U.S. forces in today's environment. Fifth Air Force encountered many challenges, but it was ultimately successful in its campaign to destroy the Japanese air force, defend U.S. forces from air attack, isolate the enemy in support of the ground war, and provide close air support when required. The organization, training, equipment, planning, and operations of the engineers who supported the Fifth Air Force will be examined in parallel with today's Air Force engineering capability to determine if some of these lessons learned can be applied today.



Figure 2: Distances to the South China Sea

Source: Dakota L. Wood, "2019 Index of U.S. Military Strength," The Heritage Foundation, 2019, 189, https://www.heritage.org/sites/default/files/2018-09/2019_IndexOfUSMilitaryStrength_WEB.pdf

Mitigation Philosophies and Programs

The U.S. Air Force has recognized the risks associated with adversary area denial capabilities and is developing several programs to mitigate them. These programs can generally be categorized under three distinct labels: hardening, dispersal, or recovery. Hardening is a passive measure that reduces the damage caused by an enemy attack; examples include construction of Hardened Aircraft Shelters (HAS) (Figure 3) to protect aircraft from attack and redundant mission critical infrastructure. Aircraft shelters also provide additional benefits such as protection from chemical attacks. However, hardening can be prohibitively expensive and difficult to implement because of the multitude of airfield vulnerabilities that need to be considered.



Figure 3: F-16 in front of a Hardened Aircraft Shelter at Balad Air Base, Iraq
Source: Carlo Kopp, "Hardening RAAF Air Base Infrastructure," *Air Power Australia*, 5 February 2008, <http://www.ausairpower.net/APA-2008-02.html>

Dispersal is another method for mitigating the threat to large airbases. Dispersal can be used to distribute aircraft throughout a single airfield, or it can be used to disperse aircraft to many airfields that are often networked. Similar to hardening, creating very large parking ramps or dispersed hardstands can prove economically difficult, and construction requires significant time.¹³ Additional airfield pavements are also permanent, so the Air Force's operational flexibility is reduced when relying on dispersal at a single airfield.

On the other hand, dispersing aircraft at multiple airbases (also referred to as distributed basing) complicates an adversary's targeting and improves operational flexibility. There are many regions that already have numerous airfields that would be candidates for distributed basing, and many of these airbases would require a limited amount of permanent construction when compared to other mitigation methods. The Air Force's "Rapid Raptor" initiative is a concept being exercised that allows a flight of F-22s to be recovered at a remote base and then regenerated using only fuel, supplies, and armament that can be transported by a single C-130 or C-17. This concept would allow combat aircraft to strike a target set and be rapidly regenerated without incurring the long delay involved with leaving the area of operations.¹⁴ Aircraft could occasionally be rotated out of the area of operations for substantial repair and recuperation. Currently, the Air Force Installation and Mission Support Center is coordinating the Combat Support Wing concept, which aggregates combat support capability in a manner designed to increase flexible combat support to multiple locations when compared to the traditional wing organization.¹⁵

Lastly, the Air Force Civil Engineer Center is developing multiple airfield recovery technologies to enable civil engineers to quickly return an airfield to operational status following an attack. The Rapid Airfield Damage Repair (RADR) program is designed to counter the

adversarial shift from inflicting large airfield craters to denying airfields by using widely scattered submunitions that create large spall areas. The initiative uses a large amount of heavy equipment and a quick-set concrete to restore an airfield in much less time than using traditional methods.¹⁶ Additionally, the Recovery of Airbases Denied by Ordnance (RADBO) program is the Department of Defense's first ground-based weaponized laser system that is used to destroy munitions.¹⁷ Lastly, the Rapid Airfield Damage Assessment System (RADAS) is an Unmanned Aerial System (UAS) that allows engineers to rapidly assess airfield damage (Figure 4). This capability provides significant advantages when recovering from a submunition attack because airfield assessment can occur simultaneously with ordnance disposal.¹⁸



Figure 4: Rapid Airfield Damage Assessment System Prototype

Source: JBER Public Affairs, "PACAF Cultivates CE Airmen with Ground-Breaking RADAS Training," *Joint Base Elmendorf-Richardson*, 30 January 2019, <https://www.jber.jb.mil/News/News-Articles/Article/1744474/pacaf-cultivates-ce-airmen-with-ground-breaking-radas-training/>

These concepts and capabilities are being developed at the staff level and show commitment to preparing for the next major war, but the technology and processes alone will not guarantee U.S. forces freedom to operate in contested environments. A stagnant readiness culture has permeated much of the Air Force with respect to preparation for large-scale conventional war; with respect to the civil engineer community, this stagnation has manifested itself in many squadrons and operational staffs in the form of inefficient organizational structures, poor training, and insufficient equipment. The Air Force civil engineer community must reinvigorate its traditional culture of readiness as it seeks to improve its organization, training, and equipment. These improvements are essential to the projection of combat power through distributed operations.

Readiness Culture

Air Force civil engineers have a proud historical culture of expeditionary operations and readiness dating by the World War II. Recently, civil engineers have performed a variety of both Air Force and joint engineering tasks in support of counterinsurgency operations in Afghanistan, Iraq, Syria, and numerous other locations. These tasks included basic military engineering tasks, large-scale construction, provincial reconstruction, explosive ordnance disposal, and firefighting among many other tasks. Many career fields reached an operational tempo at which they deployed for six months each year,¹⁹ and a robust readiness culture existed that suited counterinsurgency and stability operations.

However, this tempo also detracted from traditional core tasks of Air Force civil engineers. As the operational tempo began to decline in 2011,²⁰ an opportunity was missed to refocus on core tasks. Instead, other tasks replaced readiness training as squadron, group, and

wing priorities. While many civil engineers today will still state that readiness is the first priority, this is not the case when examining where squadrons and staffs invest their time and resources. Declining garrison facility conditions and a limited budget have taken centerstage in the Air Force civil engineer community. These are important issues because many facilities enable critical flight training missions or even combat operations launched from the continental U.S.; however, Airmen engineers have shifted focus to facility asset management to such a degree that focus on readiness is now substandard.

This situation represents a disconnect when analyzed through the lens of Schein's "Three Levels of Culture." The three levels are artifacts, espoused beliefs and values, and basic underlying assumptions.²¹ The artifacts of the current civil engineer culture demonstrate where true priorities lie, and they are often in direct conflict with the espoused belief that readiness is the first priority. Simple artifacts such as the commander's calendar, company-grade officer involvement in training planning, and the ability of Airmen to articulate how their daily work translates to the Air Force's ability to generate combat sorties can highlight how readiness is prioritized within an organization's culture. Often times, these organizational artifacts do not support the espoused beliefs and values that readiness is the first priority.

These artifacts at the squadron level are products of a larger culture within the Air Force that deemphasize the importance of expeditionary engineering and the operational impact of installations. The consolidation of engineering programs under Air Force Materiel Command (AFMC) and the subsequent exodus of rank, personnel, skills, and experience from the other major commands²² deepened the chasm between engineers and operators that they support. These recent staff reorganizations have led to senior command engineers being eliminated or

working for acquisition engineers, security forces officers, or aircraft maintainers instead of the operators that they support; this is evidenced by civil engineer functions moving from the two-letter level to the three-letter level at the Air Staff and major commands.

Furthermore, AFMC's primary focus is on the acquisition of major weapons systems and the associated budgets and processes; in many cases, AFMC is working to standardize the acquisition and management of installation real property with its major weapons system acquisition processes. While technology and processes are important to the future of expeditionary engineering, it is a decidedly people and team focused activity. This difference in mindset and the decaying access between operators and engineers provide the larger context of the civil engineer readiness crisis.

While these behaviors outline the underlying assumptions of segments of the Air Force, these disconnects have not yet reformed basic underlying assumptions of the civil engineer community as a whole. Uniformed civil engineers very much believe that the expeditionary and combat support roles are the reasons for their existence. As a community, engineers must refocus on building a culture of readiness. Leaders must ensure that organizational artifacts align with the espoused belief that readiness is a priority regardless of cultural obstacles imposed by the larger Air Force; until this happens, civil engineers will continue to deceive themselves regarding the true state of their organization's readiness. This deception could ultimately prove to be more dangerous than the underlying lack of readiness itself.

Organization

Doctrinally, Air Force civil engineers are primarily organized into two different categories of forces. Prime Base Engineer Emergency Forces (Prime BEEF) are teams that are

assigned to garrison civil engineer squadrons that are “capable of rapidly responding worldwide to provide the full range of engineering expertise and emergency services needed to establish, sustain, and recover bases for employing Air Force weapon systems or supporting joint, interagency, or multinational exercises.”²³ In contrast to the other services, these teams are embedded in garrison level workforce during peacetime and between deployments with the goal of eliminating the inefficiency associated with a force in waiting and providing valuable opportunities for Airmen to work alongside civilian master craftsmen. Prime BEEF skillsets include a variety of engineering skills necessary to open, operate, and recover an airbase from attack to include light organic construction capability, engineering design, construction contract management, firefighting to include aircraft crash/rescue, and explosive ordnance disposal.²⁴

The other type of Air Force civil engineer unit is known as Rapid Engineer Deployable Heavy Operation Squadron Engineer, better known as RED HORSE. These self-sustaining squadrons are designed to execute heavy construction in elevated threat environments. They are typically assigned to a numbered air force instead of a flying wing because they are designed to be employed as a theater asset. When deployed, they typically report to the Commander of Air Force Forces (COMAFFOR) for the theater or joint task force in which they are assigned.²⁵

Currently, there are four RED HORSE squadrons and approximately 87 active duty civil engineer squadrons that contain Prime BEEF teams.²⁶ This balance is not conducive to success in a conventional war environment that requires distributed operations given the current skillsets and experience possessed by both types of units. In order to fill this void, the Air Force could increase its number of RED HORSE squadrons, but this is not a realistic option given current Air

Force budget priorities.²⁷ Increasing Prime BEEF capability with the existing manpower is the most realistic and cost-effective option.

An understanding of Prime BEEF organization and employment is necessary to consider how this capability can be improved. By nature, civil engineer squadrons are designed to support both garrison and expeditionary requirements. Engineers work alongside civilian counterparts and gain experience in a wide variety of tasks as they construct, maintain, and repair installations and support the mission of their assigned wing in garrison. They will rarely deploy in support of their assigned wing; instead, they will be tasked to an Air Expeditionary Wing (AEW) or a joint task force that may not require the same skills that were developed in garrison.²⁸ For example, a power production Airman stationed at Vandenberg Air Force base can be expected to have significant experience in maintaining mission-essential generators related to space launch capabilities; however, he may deploy in support of an F-16 squadron where he is expected to maintain an aircraft arresting system to safely recover jets during emergencies. While that Airman was exposed to aircraft arresting systems during initial training and centrally managed training and exercise venues such as SILVER FLAG, he is likely not proficient in operating and maintaining the system on a daily basis. This creates significant risk not only for the members of his team and the pilot of a jet that may be relying on his skill set, but also for the continuous operation of the airfield in a combat environment.

Under this construct, home station installations rely on military labor to operate and maintain airfields, facilities, and infrastructure. For this reason, squadrons rarely deploy as an entire unit because of the void in engineer capability it would cause at the installation level. Most Airmen, including civil engineers, deploy as members of Unit Type Codes (UTC), which are groups of personnel and equipment through which forces are presented to deployed

commands. These UTCs allow planners to tailor specific capabilities to requirements to employ personnel in the most efficient manner as possible.²⁹ For example, a deployment of a fighter squadron will require basic engineer teams (UTC: 4FPET) combined with a handful of other skillsets such as a Power Generation/Aircraft Arrest team (UTC: 4FPAP) or an Engineer Pavements Construction Team (UTC: 4FPAS). Additional UTCs can be added depending on the specific situation; if substantial water purification is needed, planners can add a Water Systems Team (UTC: 4FPAU).³⁰ This construct allows planners to efficiently merge capabilities while avoiding the deployment of Airmen who possess skills that are unnecessary in a given situation.

While this organization is efficient, it can also result in a lack of unity and organizational dysfunction. UTCs are usually provided from different squadrons located at different installations. As a result, an Expeditionary Civil Engineer Squadron will consist of a collection of UTCs that originated from different squadrons. If lucky, these UTCs will meet in a training environment for anywhere from a week to a month prior to deployment during which time the commander can assess the various leaders and teams and mold them into a functional squadron. Ideally, the commander only needs to organize a limited number of large UTCs into the squadron; however, oftentimes the commander must meld a large number of small UTCs into a single, effective team on a rapid schedule. Establishing proper command relationships when organizing dozens of five-man teams is tedious at best, and it forces the squadron to focus solely on internal issues at the beginning of a deployment when it should also be looking externally to examine friendly requirements and enemy threats.

Furthermore, the objective wing concept that marries an engineer squadron to a single installation is problematic when considering a war that requires airfield dispersion. For years,

engineers organized with the idea that a single installation is itself a weapons platform designed to launch aircraft, and there has been little focus on how to support operations at numerous lesser airfields. The most recent publication of Air Force Doctrine Document 3-34, *Engineer Operations*, addresses this capability gap by defining the Expeditionary Civil Engineer Group (ECEG), which can merge multiple heavy and light engineer squadrons within a single command in order to support multiple locations within an area of operations using a hub-and-spoke concept.³¹ The ECEG concept was proven to be successful with the standup of the 577th Expeditionary Prime BEEF Group that consisted of engineer squadrons at Mazar-i-Sharif, Kandahar, and Bagram in Afghanistan. The group transitioned into the 1st Expeditionary Civil Engineer Group as it gained a RED HORSE squadron and enhanced its capability around the CENTCOM AOR.^{32, 33} However, these groups were primarily employed in a joint task force construct to support a variety of ground and air component missions. The Air Force's ability and willingness to employ such a concept to maintain a network of airfields is unclear and unproven.



Figure 5: Civil engineers repair the Qayyarah West runway to enable the Mosul Offensive
Source: SSgt Charles Rivezzo, “Q-West to Support Mosul Offensive,” *Air Forces Central*, 25 October 2016, <https://www.afcent.af.mil/News/Article/985022/air-force-engineers-restore-q-west-to-support-mosul-offensive/>

From a historical perspective, the U.S. Army recognized the need for engineers dedicated to the construction and operation of airfields after Germany’s invasion of Poland in 1939. The Chief of Engineers began development of aviation engineer units to meet this need. Aviation engineer battalions were organized in a drastically different manner than present day civil engineer squadrons.³⁴ First, they were much larger and had significantly more construction capability than the traditional civil engineer squadron. Each aviation engineer squadron consisted of 24 officers and 687 enlisted soldiers in October 1941.³⁵ These numbers eclipse today’s RED HORSE squadrons, which are typically manned with approximately 400 Airmen³⁶, and it well

exceeds most civil engineer squadrons when elements that do not provide direct combat support are eliminated from consideration.

These highly capable engineer battalions were organized into an engineer regiment that was assigned to a theater engineer. Consolidating engineer capability under a theater engineer allowed unity of effort as centralized priorities were determined and executed. However, the United States Army Services of Supply maintained control over the aviation battalions in the Southwest Pacific which generated friction with air force commanders. Major Gen George Kenney made multiple requests to move aviation engineer battalions under his command in order to better support the air war, but all requests were denied by General MacArthur based on the recommendation of the Chief Engineer of the Southwest Pacific Theater, Brigadier General Hugh Casey. As a result, aviation engineers were occasionally assigned to other tasks that were not in support of the air war.³⁷ This decision had major consequences because the ability to construct and operate airfields often determined the rate of advance of Allied forces in the Southwest Pacific, especially in New Guinea and the Philippines.

The sharp differences between today's Air Force civil engineer organization and the aviation engineer battalions of World War II are readily apparent. First, the aviation engineer community of World War II had significantly more manpower and resources to draw from than today's Air Force civil engineer organization. There are only four RED HORSE squadrons on active duty, which represents only slightly more manpower than two aviation engineer battalions of World War II. Secondly, the U.S. Army had a mechanism to rapidly generate additional engineer capabilities. The U.S. Army grew its aviation engineer force from just three battalions in June of 1940 into fifteen battalions by the start of the war. This highlights the fact that the Air Force must be able to rely on the Total Force to rapidly deploy significantly more capability than

is maintained on active duty into expeditionary squadrons. Lastly, Prime BEEF engineers must be able to fill the capability gap between engineer dispersal requirements and what RED HORSE squadrons can provide.

Additionally, Air Force engineer capability should be consolidated at the theater level to support major combat operations when dispersal through an airfield network is required. In order to support a large-scale conventional air war, expeditionary engineer groups should be assigned to the Joint Forces Air Component Commander (JFACC) or the numbered air force responsible for the area of operations. Engineering capability needs to be owned by a level above the wing to ensure that the most important theater level requirements are prioritized and executed. Additionally, a network of theater airfields would need coordination at the air component level. Allowing individual wings to manage their own dispersed airfield networks would prove inefficient and difficult to implement. The key to opening, operating, and recovering dispersed airfields is to centralize engineering capability under an Air Force commander at the theater level. Emphasis should be placed on assigning available RED HORSE capability to move throughout the theater to conduct heavy construction and repair operations while smaller Prime BEEF teams are dispersed to numerous operating locations to operate, maintain, and recover airfields.

The Air Force must also address the longstanding problems associated with organization of in garrison civil engineer squadrons under the UTC system. While the current system of deploying engineers in ever smaller teams efficiently tailors capabilities to problems, it could prove disastrous in dire situations that require large teams of proficient Airmen to accomplish a mission together. Airmen should not be deployed in teams smaller than the basic engineer team

UTC (4FPET, or PET team) of 25 Airmen unless absolutely required. A team of this size allows for considerable tailoring for typical rotational deployments, but still allows a leadership assessment of capability and training as well as some level of team cohesiveness. Regulations should be adjusted to ensure that smaller UTCs are attached to their own organic PET team to ensure unity of effort and to improve organization. However, even this is not ideal for large scale operations. Squadrons should be prepared to deploy as a whole in support of a major war; such a deployment is almost unthinkable in the current construct. Deploying as an entire integrated unit places the commander in a position to effectively train and employ his unit's capabilities instead of relying on someone else's preparation.

However, this proposition is problematic in the current environment of continuous rotational deployments. Installations currently rely on military manpower for operation and maintenance, and larger deployment teams would create a lack of capability during rotations that would result in degraded support. However, failure in many garrison environments is much preferred to failure in a critical wartime environment, although there are exceptions such as installations with nuclear missions. Over time, the Air Force must pursue closure of its excess infrastructure not only eliminate unnecessary facility costs but also to realign military manpower to curb the problems associated with rotational deployments. For example, military manpower could be consolidated at select bases to the point where there are two military squadrons assigned to some installations. This would allow one squadron to deploy on a rotational assignment with no impact on the garrison mission.

After being deployed in theater, squadrons need to quickly determine which dispersed facilities and infrastructure that they are responsible for and forward deploy forces as required. This would likely require a change in squadron organization because squadrons are currently

organized for the support of a single airfield. While ad hoc teams are often organized as the situation dictates, a change in the traditional command structure should be considered in the deployed environment to tailor available skills to the assigned assets. However, this would largely depend on the nature of the operating locations and the distance between them.

There are many benefits to the current organization that cannot be lost. First, the opportunity to work with civilians in the garrison environment makes Airmen some of the most technically proficient craftsmen in the military. Airmen work side-by-side with civilian employees who have been experts in their trade for decades. This feature should be protected. Similarly, the ability to deploy in smaller UTCs is a trademark of Air Force efficiency. Most deployments will not require entire squadrons to be deployed, and the UTC structure can provide effective combat support to both deployed and home station commanders in this situation. However, this ability has been abused, and the Air Force should avoid deploying UTCs of less than 25 Airmen unless they are attached to other UTCs from the same squadron.

Needless to say, there is immense room for improvement in the organization of civil engineer organizations necessary to support a major conflict with a peer adversary. Currently, civil engineer units are best organized to support garrison requirements and rotational deployments. These missions are successfully completed on a routine basis. However, this construct is at risk of failure in the face of large-scale theater war and should be further assessed and improved.

Training

The recent focus on technological development and process improvement to support airfield recovery demonstrates the Air Force's recognition of the threat to large U.S. air bases. However, the threat requires engineers to improve training in basic engineer and combat skills in addition to implementing new equipment and processes. Engineers are unable to meet current training requirements due to garrison requirements and deployments, and training requirements need to be reexamined to ensure that they provide the skillsets and training time necessary to prepare engineers for distributed operations. The combination of an inadequate training program and the current functional wing organization elevate the risk of failure in a complex attack against airbases.

Expeditionary skill sets have largely been in decline over the last decade. Many engineers completed annual engineer training and attended a four-week Combat Skills Training each year in support of their rotational deployments as deployment-to-dwell ratios rose steeply for some Air Force Specialty Codes (AFSC) at the height of the surges in Iraq (2008) and Afghanistan (2010-2011).^{38,39} Over time, this training battle rhythm became difficult to manage and redundant in some cases, so many training programs were reduced or adapted to a "just-in-time" concept that supported regular rotations in support of counterinsurgency and counterterrorism operations.⁴⁰ The skill sets required to support both air and joint operations in a counter-insurgency environment were well practiced and often executed, so there was little need to spend excessive time on them.

As discussed previously, Prime BEEF teams often deploy to an Air Expeditionary Wing that has little relation to their assigned home station wings. The result is that the home station wing has little stake in training engineers for their war-time mission. This situation was

compounded when the Air Force decided to eliminate mandatory cross-functional wing-level exercises and inspections (Phase II Operational Readiness Exercises and Inspections) because forces were employed regularly in theater.⁴¹ This decision fully detached wings from the responsibility to ensure that engineers are adequately trained to meet their wartime requirements, and there is no longer accountability through exercises or inspections to ensure that engineers are ready to execute their combat support roles.

While skills have decreased overall, many combat and engineer skillsets required to execute a large-scale theater war have eroded the most due to this reduction in training. Skills that were frequently practiced in just-in-time training programs such as combat skills training programs are also now atrophying due to the reduction in deployments associated with drawdowns in Asia. While a lack of training can be recognized and remedied, the structure, resources, and experience necessary to provide realistic training have also diminished; this fact creates a long road to recovering valuable expeditionary engineer skills.

The deficit in civil engineer training is highlighted by 2018 statistics describing the state of civil engineer home station training. Air Force-wide, civil engineer squadrons were current in only 57% of their required training tasks. Notably, the highest training completion rates are found in the SILVER FLAG and Mission Essential Equipment Training (MEET) programs that are centrally managed at the Air Force Civil Engineer Center and are generally unaffected by wing priorities. The lowest major category training currency rates are found in General Contingency and Combat Skills (55%) and Vehicle Equipment Operations (44%) training programs. These programs are managed at the squadron level, and they are affected by wing priorities. Several specific training tasks completion rates sunk below 40% to include Integrated

Defense (29%), Land Navigation (39%), Tactical Convoy Operations (30%), Contingency and Disaster Planning (34%), Disaster and Attack Preparations (36%), and Planning and Design of Expeditionary Airbases (32%).

While training is never fully complete due to leave, deployments, and unforeseen circumstances, it is evident through these statistics that there is a prevalent shortfall in training completion at the squadron level. Furthermore, some of the skillsets that show the lowest completion rates are also the skillsets that could prove to be the most important in distributed basing operations. Integrated base defense skills are largely unused in current conflicts because of the large, well-protected, steady-state airbases in Iraq and Afghanistan. As a result, civil engineers are typically only concerned with temporary work-site security. Similarly, very little thought is put into airfield attack preparations in current deployment environments because there is little threat beyond sporadic indirect fire. However, this skillset is a core skill that should be possessed by Air Force civil engineers, and it could prove to be critical in a high threat distributed base operation.

The Air Force must step back from its current training program and examine what the true requirements are to sustain distributed operations in a theater war, and then assess the risk associated with not completing the prescribed training. The Civil Engineer Wartime Task Standards (CEWTS) is a valuable format for capturing training requirements and assigning training tasks, frequencies, and proficiency levels. However, the training frequencies are currently mismatched with the stated required proficiency levels. For example, the CEWTS lists tactical convoy and integrated base defense as skillsets that civil engineers should be able to complete “most parts of the task” and need assistance with only the “most difficult” scenarios.⁴² This is a reasonable assessment given the assumption that civil engineers will primarily work

independently in a medium or low threat environment, and that significant land component forces would be necessary to support operations in higher threat levels.⁴³ However, the CEWTS only allows eleven hours of instruction and training every eighteen months to achieve this level of proficiency for these tasks.⁴⁴ Similarly, officer training for beddown planning has been narrowed to a half hour of computer-based training every thirty-six months;⁴⁵ in the past, officers were trained and tested through a beddown exercise that was conducted roughly each quarter. These exercises tested the ability of officers and senior NCOs to rapidly plan and organize an aircraft beddown at a specific location.

One last example is a recent change in weapons training and qualification. In previous years, civil engineers qualified on their weapons on a routine basis; presently, they only fire when tasked to deploy.⁴⁶ This arrangement may be adequate for routine rotations when the deployment tempo is high, but it will not suffice when a large number of civil engineers are suddenly tasked to deploy in support of a major theater war. Only a basic familiarization is possible in the listed training times for all of these tasks, and the Air Force must recognize that there is a disconnect between the stated required proficiencies and the projected training time.

So, if the civil engineer training program should be redesigned to support distributed operations, which elements of the program should change? First, engineers must understand their connection to the aviation mission in the context of distributed operations. The officer corps must understand the nature of airfield networks and how the operations community intends to use them, which is not abundantly clear at the moment. One well-reasoned construct is described in “Making Places, Not Bases a Reality,” in which the author categorizes all airfields in the INDOPACOM region based on the types of aircraft that they could support, and then

describes infrastructure improvements and criteria changes that would generate enormous flexibility in how airfields could be used. The author also suggests airfield groupings based on regions that would simplify logistics and support.⁴⁷ The logistics and support concepts necessary to support such an operation are left undeveloped. The civil engineer officer corps along with airfield operations and communications communities must develop these concepts of support. This level of understanding and development cannot be addressed through the widespread use of computer-based training programs.

After the mission is understood, company grade officers and non-commissioned officers must be prepared to lead in relative isolation within the context of distributed operations. While many have led superbly within the context of counterinsurgency support, they must learn how to independently operate, maintain, and recover airfields with smaller teams and less support. This implies a better understanding of the necessities of operating airfields (potentially multiple airfields), more flexibility in using indigenous materials and equipment, improved tactical communications skills to coordinate support for aviation assets, a good understanding of the culture in which they will operate, improved use of airfield deception, and many other skills. None of these skills are new; engineers from all services have employed them many times to support air operations, but the lack of readiness focus has resulted in a decayed force that is not prepared to succeed in these areas.

The preparation of the junior enlisted force is equally important. A greater focus on foundational engineering skillsets and expeditionary skills is necessary. The demise of the enlisted liquid fuels career field provides a prime example. The Air Force decided to merge the liquid fuels and utilities systems AFSCs to create the Water and Fuel Systems Maintenance specialty. This decision gutted the Air Force's ability to provide organic fuels systems

construction and repair, and it now relies heavily on Defense Logistics Agency resources to contract the majority of repair work. While this decision may have been somewhat successful at improving garrison monetary efficiency, it drastically reduced Air Force civil engineers' capability to repair war damaged fuels infrastructure. While constructing temporary bladders is still an option, the long-term challenge of operating infrastructure such as pumps is problematic. New Airmen being training in Water and Fuels Systems Maintenance skills are learning the basics of fuel maintenance, but there is anecdotally a large skill and experience gap when compared to the legacy liquid fuels personnel on active duty. This skill and experience gap will continue to expand as the last remaining liquid fuels personnel retire. The Air Force needs to identify the critical technical skills it needs to implement distributed operations and organize around those requirements.

The Air Force must also target the expeditionary skills proficiency of the enlisted force. After the civil engineer community has evaluated the CEWTS as described earlier, it must add accountability to ensure that expeditionary training tasks are completed and tested at both an individual and team level. The Air Force does a good job of ensuring enlisted career development course and skill level upgrade training requirements are met. The civil engineer community should impose a similar level of accountability for expeditionary training tasks.

One of the many challenges faced in rebuilding an engineer training program is the lack of training equipment. Many types of equipment that civil engineers are expected to employ in theater were maintained at the squadron level in the past. Engineers could routinely train on the equipment and employ it in exercises. Much of this equipment has been consolidated at Grissom Air Force Base for cost efficiency in the last decade for cost efficiency.⁴⁸ Similarly, individual

equipment issue has moved to various Aerial Ports of Debarkation (APOD) or to the Logistics Readiness Squadron at many installations. While this consolidation saves costs and protects equipment from damage, it prevents engineers from conducting realistic training on a routine basis.

In stark contrast, aviation engineer battalions of World War II were organized and trained from their origin to operate as an integral unit. For example, the 840th Engineer Aviation Battalion was originally formed at Bradley Field, Windsor Locks, Connecticut. The battalion was formed with a 35-soldier strong cadre from other engineer units along with 530 soldiers that were primarily new recruits from induction centers around the country. The cadre conducted basic training for the battalion, which included basic combat skills as well as technical engineering training. After this primary training was complete, approximately 200 more personnel were added to bring the total battalion strength to 31 officers and 765 enlisted. From the outset, each soldier had primary engineering and combat tasks that he was trained in that complemented the training of other soldiers in the battalion.⁴⁹ The result was a well-integrated team that performed well in combat conditions in Great Britain, England, France, and Germany. Of course, the construct of today's Air Force would not support the cradle-to-grave nature of the 840th, but the Air Force should strive to create the same level of integration and training that was accomplished in 1941.

Another compelling aspect of engineer aviation battalion preparation was its participation in large-scale Army Air Corps exercises. The Louisiana Maneuvers in the fall of 1941 provided an opportunity for engineer aviation battalions to demonstrate their capability in a relatively unstructured environment. Engineer units were given objective tasks such as extending short runways, improving pavements, constructing dispersed parking areas, and implementing airfield

camouflage techniques at local and regional airports in Louisiana and southeast Texas in support of a large-scale air exercise. Units demonstrated their readiness for combat operations and learned many lessons regarding the best methods for constructing and operating expeditionary airfields. Most importantly, they gained authentic experience in actual construction and repair efforts that were immediately utilized in air operations.⁵⁰

In contrast, today's Air Force civil engineer units are unlikely to gain the similar experience and skillsets in today's exercises. As identified earlier, Operational Readiness Exercises are no longer required and have been largely abandoned with the exception of squadrons in high risk areas such as the Pacific or Europe. SILVER FLAG remains as the premier expeditionary civil engineer exercise for Airmen. The benefits to the current structure of SILVER FLAG are that it provides key training on expeditionary equipment that Airmen typically aren't able to use during routine operations at the squadron level. However, the exercise portion of SILVER FLAG is a structured scenario that typically involves a single day of force beddown and airfield damage repair. While engineers may walk through a beddown planning exercise, the beddown plan is largely performed for the participants. For example, the airfield never changes, and beddown equipment is typically located in the same place time after time. Airmen are often sent to SILVER FLAG in smaller teams that replicate the manner in which they deploy. However, this practice is to the detriment of tasks that require large team coordination such as the Rapid Airfield Damage Repair initiative. Cycling small teams through the exercise may create a level of proficiency within single Airmen, but larger teams are never able to train and demonstrate proficiency at large-scale tasks. One exception is theater level exercises such as Exercise Resilient Shogun (Figure 6); however, CONUS-based squadrons that

will be relied upon during a major war typically do not have the opportunity to participate in similar exercises.



Figure 6: Engineers execute rapid airfield damage repair during Exercise Resilient Shogun

Source: SrA Stephen G. Eigel, "PACAF civil engineers improve airfield repair skills," *Pacific Air Forces*, 16 September 2016, <https://www.pacaf.af.mil/News/Article-Display/Article/946363/pacaf-civil-engineers-improve-airfield-repair-skills/>

The Air Force should also further invest in some level of both engineer and personal training equipment. Specifically, AFI10-210 should mandate a standard equipment issue to each Airman for training use; if necessary, second-hand equipment being disposed of by the Army could be used to reduce costs. It is unacceptable to require Airmen to train to a standard for which they are not equipped. If engineers cannot be appropriately equipped for training, that training task should be eliminated, risk should be deliberately accepted, and the time should be reallocated to a task for which they are properly equipped.

The Air Force should also reinstitute civil engineer requirements in Operational Readiness Exercises and Inspections. Inspections should entail accountability at the wing level for the preparedness of civil engineers to rapidly deploy, open, sustain, and recover an airfield

after attack. The recent change to AFI10-210 that made most civil engineer training requirements reportable is a step in the right direction, but it will only encourage box checking if there is no true measure of unit performance. Exercises should be conducted quarterly, and scenarios should be varied to account for today's operating environment to include airfield dispersal concepts. Ideally, civil engineer operations should integrate into larger wing exercises, but they would still be of value even if they were conducted independently.

Lastly, the Air Force must field its newly acquired technology in a manner that allows Airmen to train within the organizations that they are assigned. The value of individual tasks that are learned at large-scale training exercises such as SILVER FLAG is rapidly diminished when Airmen attend the exercise as individuals and then deploy with Airmen from other squadrons.

Equip

The ability to adequately equip and sustain military engineering operations in support of airfields has been problematic throughout history. Substantial horizontal work requires significant amounts of material and heavy equipment that will likely be operated far outside of its intended operating conditions. Many Prime BEEF units do not maintain deployable heavy equipment. Equipment is typically allocated to support the assigned garrison, and Prime BEEF teams often rely on equipment procured in-theater for expeditionary operations. Once acquired either through supply channels, purchases, or leases, supply chains are often too slow to support construction, and it can be difficult to communicate the true importance of seemingly non-critical

material. Military services often do not recognize the importance of this engineering material and equipment until it is urgently needed in the field.

Current Air Force operations illustrate these challenges well. A RED HORSE squadron in conjunction with a Prime BEEF team were recently deployed to construct a new air base in the Sahara Desert to support Intelligence, Surveillance, and Reconnaissance operations in the region. A construction update from September 2018 highlighted that only 47% of the squadron's vehicles and heavy equipment were operational. Out of six bulldozers and six loaders, only one of each was operational at the time.⁵¹ Needless to say, the construction of an entire airfield on a strict timeline is extremely challenging with such unreliable equipment. Of note, RED HORSE squadrons possess organic maintenance capability, so the equipment failures are unlikely related to failure to perform adequate preventative maintenance. Military engineers must push equipment to its limit to achieve operational goals, and the equipment will be worn and damaged in the process. It is essential to secure good, working equipment and to establish reliable supply operations for parts and material to ensure success.



Figure 7: Engineers construct an airfield in the Saharan Desert

Source: Photo, Unpublished, Received as email attachment from Major Joshua Hager, 8 November 2018.

Aviation engineers in the Pacific would doubtlessly agree with the importance of well-established supply for heavy equipment. Engineer aviation battalions were much better equipped than most Air Force civil engineer squadrons today (Figure 8) because the necessity of construction and repair was well recognized. As noted in *Engineers of the Southwest Pacific*, “the success of the entire projected offensive in New Guinea was dependent upon the success of the initial engineer mission in Papua.”⁵² The scale of airfield construction in New Guinea was enormous, and there are numerous references to heavy equipment being out of operation. At the end of July in 1944, the availability rate for graders and bulldozers were 20% and 49%, respectively.⁵³ Supply became even more important as American forces progressed further away from their primary supply sources in Port Moresby and Australia. Elaborate supply networks were established to specifically support mission critical engineer efforts. Although Allied efforts were ultimate successful, there are many instances where operations were detrimentally affected by the engineers’ lack of operable equipment and their subsequent inability to complete mission critical airfield construction.⁵⁴

HEAVY EQUIPMENT			
ARMAMENT		PUSH W/D-4 TRACTOR	3
MACHINE GUN	21	TANK, 750 GALLON, W/SKIDS	1
PISTOL	193	TRACTOR	3
RIFLE	504	DIESEL, D-4, W/DOZER	3
CAR, SEDAN	1	" " " " & TRAILER	3
COMPRESSOR, AIR MOTORIZED	4	" " " " " "	3
DISK, HARROW	1	" " " " " "	1
DISTRIBUTOR, ASPHALT, MOTORIZED	1	GASOLINE, RUBBER TIRED	1
GENERATOR, ELECTRIC, 5 KVA, W/SKIDS	1	TRAILER	18
GRADER, ROAD	1	1 TON	6
LEANING WHEEL, TOWED	1	8 TON	5
MOTORIZED, DIESEL	6	15 TON	1
MIXER		20 TON	7
CONCRETE, 14 CU. FT. TOWED	3	250 GALLON TANK, WATER	1
ROAD MATERIAL	1	TRENCHER, VERTICAL BOOM	1
MOTORCYCLE, SOLO	11	TRUCK	1
PLOW		AMBULANCE	4
DISC, HEAVY	3	1/4 TON, G.P.	6
TRACTOR	3	1/2 " " " " " "	12
PUMP	2	1/2 " " " " " "	1
CENTRIFUGAL	1	1/2 " " " " " "	1
DIAPHRAGM	1	1-1/2 " " " " " "	62
REPAIR, UNIT, MOBILE	1	1-1/2 " " " " " "	2
ROLLER		2-1/2 " " " " " "	3
RUBBER TIRED, MOTORIZED	1	4 " " " " " "	10
SHEEPSFOOT, TRIPLE	1	4-5 " " " " " "	7
TANDEM, 10-TON, MOTORIZED	2	6 " " " " " "	1
ROOTER, MEDIUM	1	WATER SUPPLY EQUIPMENT, PORTABLE	1
SCRAPER, CARRYALL		WELDING SET	1
3 1/2 CU. YD.	3	ELECTRIC, MOTORIZED	1
8 CU. YD.	3	OXYACETYLENE, PORTABLE	1
SHOVEL		WELL DRILLING SET, MOTORIZED	1
GASOLINE, 1/2 CU. YD.	3		

Figure 8: Standard Equipment Assigned to an Engineer Aviation Battalion

Source: Stuart C. Godfrey, "Engineers with the Army Air Forces," *The Military Engineer* 33, no. 193, November 1941, 488.



Figure 9: An engineer improves an airfield near a B-29 in the Southwest Pacific.

Source: Major General Hugh Casey, *Engineers of the Southwest Pacific 1941-1945: Volume VI, Airfield and Base Development* (Washington: Government Printing Office, 1945), Cover page.

The Air Force, and the military at large, has long struggled with the best way to provide sufficient heavy equipment in remote theaters. Construction equipment is expensive, and it must be regularly used and maintained in order to keep it in operational condition. Simply purchasing equipment and prepositioning it in harsh environments typically proves expensive and ineffective. Construction equipment that is maintained in garrison will often not receive priority

air shipment in a time of crisis due to the abundance of combat equipment that requires movement, and shipment by sea can result in long delays and lost equipment. Instead, the Air Force should attempt to form provisional agreements with suppliers in key regions for priority access, purchasing rights, and lease agreements for heavy equipment and critical repair parts in addition to any equipment that can be air shipped or adequately prepositioned. A civil engineer squadron without equipment is of limited value, and distributed basing operations would be at risk without adequately equipped engineers.

Additional Thoughts

Three other themes that stand out from a study of the Southwest Theater are the need for security cooperation, available host nation labor, and the need to reconsider contingency airfield criteria. The Allies had near total permission from the countries from which it operated in World War II. Japan was the clear aggressor, and it had often brutalized the populations of the countries that it conquered. This placed the Allies in a prime position to leverage regional partnerships because they were seen as the liberators and protectors of freedom. They had permission from governments in exile and support from guerrilla units in most of the populated countries of operation. This is a critical factor as the U.S. contemplates future war in the South China Sea. The U.S. desperately needs airfields, land, and airspace from which to operate. While the Chinese have acted aggressively in the possession of the Spratly and Paracel Islands (Figure 10), they have attempted to maintain a somewhat peaceful image by expanding economic and diplomatic relationships in the region. For example, the Chinese are continuing attempts to improve its relationship with the Philippines to the detriment of American-Philippine relations regardless of the dispute over islands within fifteen miles of the Philippine coast. Needless to

say, a conflict in the South China Sea would be difficult to win if the U.S. does not have access to Philippine territory, airspace, or support.

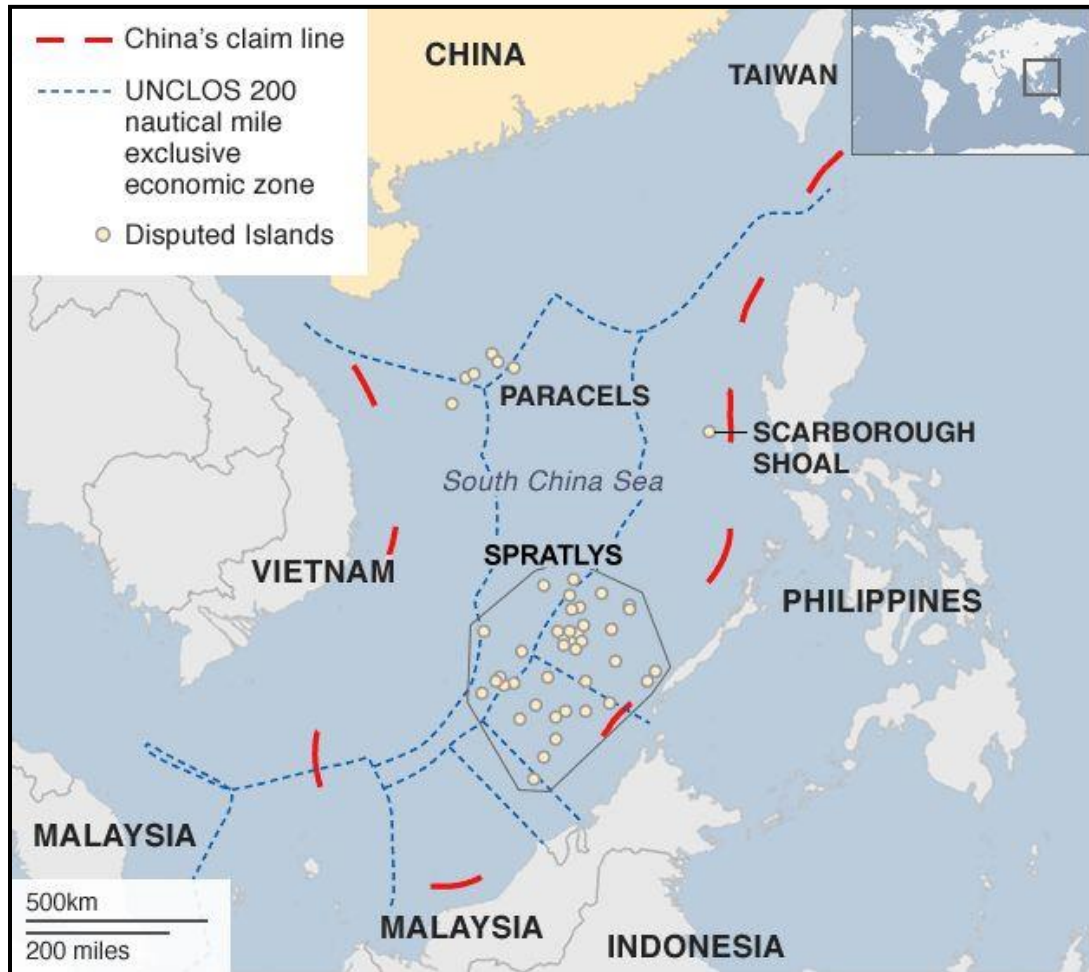


Figure 10: Paracel and Spratly Island Chains and the Nine Dash Line

Source: BBC, "South China Sea Dispute: Beijing attacks 'irresponsible' US comments", *BBC News*, 2 June 2018, <https://www.bbc.com/news/world-asia-44343368>

Of a similar nature, host nation labor has proven to be a vital component of large-scale military airfield construction in times of war. Under many circumstances, there is simply not enough military labor to complete high priority construction requirements on the desired timeline. For example, the 809th Aviation Engineer Company was assigned to improve Nichols

Field in 1941 during the defense of the Philippines prior to the arrival of other units. The company consisted of just 176 soldiers, but it was augmented by 800 unskilled native workers.⁵⁵ The Air Force has leveraged contract and host nation labor in expeditionary environments throughout its history, but it should carefully examine its capability and limitations associated with mass hiring of local nationals. The modern-day Federal Acquisition Regulation and Title 10 law could prove to be burdensome if such labor was required. Processes need to be developed now to ensure quick access to host nation labor should it be immediately required.

Lastly, the Air Force should consider studying the required airfield surfaces to support a low number of operations at an expeditionary location. Current airfield design criteria require advanced modeling techniques based on thousands of operations per year. This data is translated into a simplified Pavement Classification Number system that is easily interpreted by pilots and airfield operations specialist. However, it greatly restricts the number of available minor airfields available for dispersal efforts. Engineer squadrons should be able to quickly evaluate airfield pavement characteristics to support a limited number of operations.

Conclusion

History has shown that large-scale conventional wars can place a premium on an air force's ability to operate from a large number of dispersed airfields. The current strategic environment has placed new emphasis on this lesson as adversaries acquire a large number of advanced, precision guided standoff weapons and aircraft. The Air Force is developing plans to implement distributed operations to counter these threats, and civil engineers on staff are diligently developing new technology and processes to support these operations. However, civil engineers in the field are currently underprepared to open, operate, maintain, and recovery

numerous dispersed airfields. The readiness culture of the civil engineer community must be reinvigorated to address these issues and ensure future engineers are prepared to operate in such a war.

The doctrinal concept regarding the best method to deploy engineers to support dispersed locations is already in place, but the current method that the Air Force uses to present forces to a theater commander will result in fractured teams incapable of performing key large unit engineering tasks. The Air Force should reevaluate how it aggregates UTCs to form a deployed squadron. Each deployed squadron should be formed from as few home station installations as possible to achieve greater unity and readiness accountability.

Furthermore, engineer and combat skills training for Prime BEEF assigned personnel should be improved. The current level of civil engineer readiness for distributed basing operations in a large theater war is low. Training syllabi should be examined and refined as necessary to reflect necessary skills and the required proficiency in these skills. Furthermore, adequate training time and equipment should be provided to squadrons to ensure that training plans are feasible and productive. Emphasis on large-scale exercises should be reintroduced to civil engineer readiness programs to ensure that squadron readiness can be effectively evaluated. Engineers must be trained to a level at which small teams can operate in relative independence in order to keep numerous supporting airfields in operation during war.

Similarly, the Air Force must ensure that both home-station and expeditionary squadrons are adequately equipped with both engineer and personal equipment. Success in any engineer task is difficult without the proper equipment, and the Air Force owes civil engineers the opportunity to train with the equipment that it will operate in theater.

Air Force civil engineers have a proud tradition dating back to their Army aviation engineer roots of overcoming any obstacle to support combat operations. However, this determination to succeed in all circumstances does not alleviate the officer corps' duty to adequately prepare Airmen for the difficult tasks that lie before them. While civil engineers have performed tremendously in counterinsurgency wars in Iraq, Afghanistan, and Syria, the focus on these conflicts has resulted in a deficit in preparation for the next major conventional war. Hopefully, diplomacy will prevail over the rising tensions in the Pacific and eastern Europe. However, civil engineers must stand ready to enable decisive airpower in the next major conflict.

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