SOCIETY OF AMERICAN MILITARY ENGINEERS

TME
The Military Engineer

VIETNAM
Commemorative Issue

REMEMBERING

ELEPHANTS AND PEOPLE POWER

CONSTRUCTION OF A DELTA BASE

TURN KEY PROJECT AT TUY HOA

LONG BRIDGE AT BONG SON

CONTRACTORS IN THE COMBAT ZONE

FEATURING

PERSONAL STORIES FROM SAME MEMBERS

SAME POSTS IN SOUTHEAST ASIA

RETROSPECTIVES ON MILITARY ENGINEERING

VIETNAM, 50 YEARS LATER
Reflections and Memories

Capt. Ted Stroup, USA, working on recovery operations after the Hotel Victoria bombing on April 1, 1966, while assigned to Navy Public Works.

Looking back 50 years ago and my time in "NAM," or Vietnam, caused a stirring of emotions and, at one point, some doubt. Doubt as to whether I remembered what happened, what I did, and where I was during that time.

Well, looking back wasn't so bad—and it verified I had not gone "silly," or some other indication of the aging state. And the good news is that there are still other veterans from World War II, Korea and more recent conflicts who can be called upon to stand to be acknowledged. Our nation does remember its soldiers, sailors, airmen and Marines who have served over the years. It was for that purpose SAME embarked on this commemorative issue of *The Military Engineer*.

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I would first like to thank all who have contributed to the development of this issue. We were honored to have a number of engineer veterans (military and civilian) from all services—plus industry veterans—support our efforts and contribute time, energy, ideas and articles to complete the mission undertaken to "remember and honor" our Vietnam veterans from the Military Engineering family. An examination of this issue and a review of other histories from unit logs and reports, command histories, oral histories, and articles written during the period and after yield a great deal of "things to be proud of," whether they be individuals, units, battlefield operations, devices developed and fielded by the services, or equipment produced by our industry partners.

Military engineers were among the first to deploy to the Republic of Vietnam. The Green Beret Engineer "A" team members and the U.S. Navy Public Works detachments and commands were in country well before the troop buildup and the creation of large service organizations and commands. U.S. Marine Corps engineers were ashore ahead of the landings "scoping out what was needed and where," as were the advance parties of the Air Force engineers, before RED HORSE and Prime BEEF units were fielded to meet the needs growing rapidly for engineer support. Our government civilian engineers and scientists were on the ground examining soil conditions, power grids, and base engineer requirements such as facilities and housing and transportation infrastructure. "We Engineers" usually went in without fanfare, but with a sense of duty and professional purpose to provide the best for the troops who would follow. To recoin a popular song from the Army, "when we were needed, we were there"—early, innovative, and competent.

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I arrived in the Republic of Vietnam after a long flight on Pan Am airlines that started at Travis AFB in California, refueled at Hickam and then Wake Island, and finally landed at Tan Son Nhut AB, just outside of Saigon. It was February. The year was 1966.

I had volunteered to go, as I wanted to command a unit in combat (which really had not yet erupted on a large scale). My detailer, needing to rapidly fill growing requisition requirements, told me in no uncertain

I arrived in the Republic of Vietnam after a long flight on Pan Am airlines that started at Travis AFB in California, refueled at Hickam and then Wake Island, and finally landed at Tan Son Nhut AB, just outside of Saigon. It was February. The year was 1966.

terms that there would be a company command waiting for me. There was a lot of talk of stateside units deploying rapidly and being understrength in officers and non-commissioned officers.

Stepping off the plane at the bottom of the ramp, we were met by Capt. Archie Kuntze, USN, welcoming each of us, a mixed roster of all the services, to the Republic of Vietnam. I had arrived. Going down the stairs, I observed the handshake and words of the captain and the gesture pointing the arrivals to a processing center. All flowed as expected—process in, get your assignment, and get to your unit quickly.

Captain "K" welcomed me as "Mister Stroup" and asked me to stay behind for further instructions. When all had deplaned, he turned to me and said, "Welcome aboard, I am your new skipper here."

Needless to say, my tortured explanation of my orders went nowhere. The Navy was in charge of Public Works during this rapid buildup and needed engineer officers. I was to be in the Public Works for Headquarters Support Activity, Saigon (HSAS, or HeadSuPac, Saigon in Navy lingo), which encompassed Saigon and south to the Delta. I would be in field inspections that reported to the OINC (another Navy term, Officer-in-Charge) and would have a detail of senior Seabee petty officers on my team along with some local-national engineers. Overnight, I learned a new language—not Vietnamese, but Civil Engineer Corps and Seabee talk, along with an amazing array of Navy acronyms.

It was a great few months. I learned a lot and got to know the countryside to the south. Then the Army arrived with a headquarters, USARV—U.S. Army Republic of Vietnam. The initial mission was to receive incoming units and get its arms around the rapidly expanding demands for base infrastructure. HSAS was decommissioned and its personnel and base operations missions dispersed to the new Army command. Army units were arriving in country rapidly, as were Air Force and Marines Corps. It was a new opportunity to get to an Army engineer battalion and command a company.

Not so. I was shanghaied into the rapidly growing 1st Logistical Command, part of USARV—there was no Engineer Command stood up yet—and its initial engineer section had the mission of in-country engineer. Its job was to create bases, welcome the “tail” that would be supporting the arriving combat units, and establish the logistical base for supporting land operations. Part of the mission was building the massive Army portion of the base infrastructure. The new commanding general of 1st Log wanted a set of engineer eyes to tell him what was going on and what was needed. The command engineer tasked me to be those “eyes.” Still no company, but the command engineer promised me that if I survived the position for six months he would get me to a company command.

The diversion turned out to be a remarkable development assignment for an engineer captain. I traveled all over South Vietnam and watched USARV grow in stature and infrastructure. As USARV developed in the first few weeks, the new commanding general of 1st Log outperformed the television show *The Apprentice* on his end, including at the headquarters. By default, I became his aide, with strings still attached to the command engineer.

Well, I survived, and I finally got my company: C Company, 864th Engineers (based at Cam Ranh Bay). My new company was located some 60-km north in Nha Trang. We had multiple missions—build Camp McDermott, a logistical base; build a Hawk missile site and an Air Force radar system that looked north, all on Hon Tre Island, about 1.5-km off the coast; and keep the roads between Nha Trang and Ninh Hoa open and maintained. We also shared in base-perimeter security tasks. It was a great unit with multiple missions.

(Above) Capt. Ted Stroup, USA, with the 171st Well Drilling Detachment at Hon Tre Island, while commanding C Company, 864th Engineers. (Opposite) In the C Company prefabrication yard at Camp McDermott, Nha Trang.

We were blessed with a high mission priority and extra equipment not normal for company-size engineer units: BARCs, LARCs, our own LCM, a diving detachment, a well-drilling detachment, and a quarry/rock crusher platoon. Like everyone else, we were busy 24/7. It was a great mission set for an engineer company away from its battalion.

I was in country over 18 months. I enjoyed every minute of my duty in theater; learned a lot about other service engineer units; and experienced the big picture flying around with 1st Log. Commanding C Company, 864th Engineers was the best of my many jobs in Vietnam.

• • •

Today, working with the *TME* staff has been a great experience for me to help us recall and honor all the engineers of the Vietnam era (Army, Navy, Air Force, Marine Corps, civilian, and contractor).

So join me as you page through this special issue of *The Military Engineer* and reflect upon and remember this proud piece of our nation’s Military Engineering history. Particularly, remember the fallen engineers who served there, and all the servicemembers who gave their life. They are national treasures of our heritage as soldiers, sailors, airmen and Marines, and a solemn reminder of the sacrifices made in serving our country.

Lt. Gen. Theodore G. Stroup, P.E., F.SAME, USA (Ret.)
Alexandria, Virginia – July 2016

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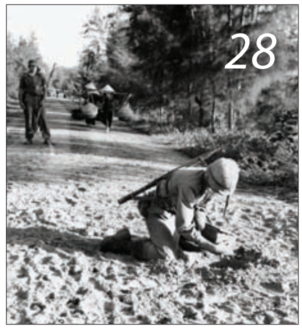

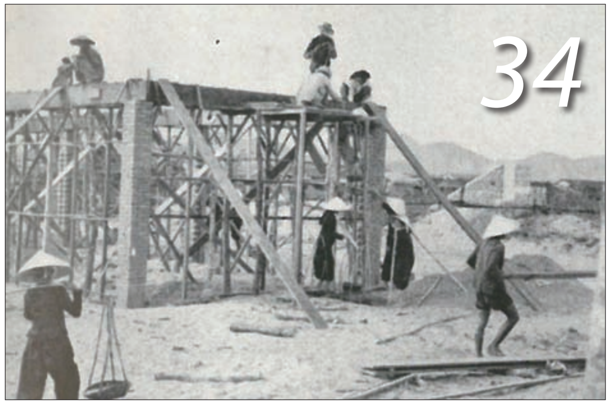

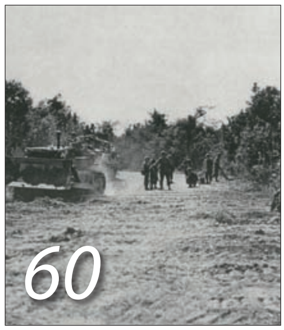

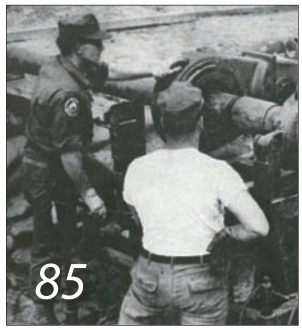

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EDITORIAL OFFICE
607 Prince Street, Alexandria, VA 22314-3117
703-549-3800 • www.same.org

STAFF

Guest Editor
Lt. Gen. Theodore G. Stroup, P.E., F.SAME, USA (Ret.)

Editor-in-Chief
Stephen R. Karl — Ext. 141; skarl@same.org

Graphic Designer
Natalie Rooney — Ext. 142; nrooney@same.org

Director of Business Development and Sales
Stephanie Satterfield — Ext. 144; ssatterfield@same.org

Web Specialist
Bruna Siloto — Ext. 143; bsiloto@same.org

Publisher
Brig. Gen. Joseph "Joe" Schroedel, P.E., F.SAME, USA (Ret.)

Reprint Inquiries
Chris Jones — 717-632-8448 Ext. 8128;
chris.jones@sheridan.com

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VIETNAM: IN THEIR WORDS

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- Col. Jeffrey Wagonhurst, F.SAME, USA (Ret.)
- Marvin Whitley
- Lt. Col. Robert Wolff, Ph.D., P.E., F.SAME, USAR (Ret.)

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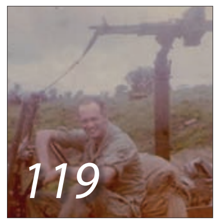
ON THE COVER: *Col. Jeffrey Wagonhurst, F.SAME, USA (Ret.) – Republic of Vietnam, 1971*



SAME IN SOUTHEAST ASIA

The Saigon, Cam Ranh Bay, Siam and Da Nang Posts along with others across Southeast Asia offered SAME members a way to get connected "over there" during the Vietnam War.
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ENGINEER MEDAL OF HONOR RECIPIENTS FROM THE VIETNAM WAR

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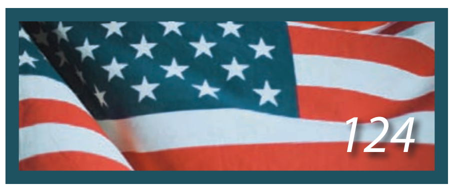


ENGINEERS: A LEGACY OF SERVICE

Senior military leaders of the Army, Navy, and Air Force recognized engineers during Vietnam. ***Pages 127-128***

THE PEOPLE WHO SERVED

The idea to publish a *TME* Vietnam Commemorative Issue originated in December 2014, at the SAME Small Business Conference in Kansas City, Mo., when Lt. Gen. Tom Bostick, USA, then-U.S. Army Chief of Engineers and Commanding General of the U.S. Army Corps of Engineers, invited on stage all those in the audience who were Vietnam veterans to help commemorate the 50th Anniversary of the war. It was a reminder that many who served are still with us today—and are still active in SAME. We knew right then we wanted to recognize the service, contributions and achievements of military engineers in Vietnam.

Vietnam has been done before. We knew that. In music, movies, television, books, magazines. How then could we add to the legacy of *our* Vietnam veterans? What could we share that was "our own"? We decided there were two unique ways that we could tell our story: one, through first-hand accounts published in *The Military Engineer* during the 1960s and early 1970s; and two, through the memories of our members—those who were there in Vietnam.

We have many people to thank for helping us conceive and develop this very special issue. Thank you foremost to Lt. Gen. Ted Stroup, F.SAME, USA (Ret.), for your steady hand in guiding us through countless discussions, brainstorming sessions and meetings with other advisors, and for always keeping us thinking back to why we were doing this. We were so fortunate to have you with us each step of the way.

Thank you also to Rear Adm. Dave Nash, F.SAME, USN (Ret.) and Maj. Gen. Gene Lupia, F.SAME, USAF (Ret.), both past SAME National Presidents, for serving as advisors and helping us understand the role of Navy and Air Force engineers in Vietnam. Thank you to Lt. Gen. Max Noah, USA (Ret.), Lt. Gen. Jerry Sinn, USA (Ret.), Brig. Gen. Gerry Galloway, Ph.D., F.SAME, USA (Ret.), and Col. Ed Gibson, F.SAME, USA (Ret.), along with Mary French and Eileen Erickson, former editors-in-chief with AUSA and SAME, respectively, for helping us frame the "realm of the possible." Thank you to Lt. Gen. Tom Bostick, USA (Ret.), Maj. Gen. Tim Green, USAF, and Rear Adm. Bret Muilenburg, CEC, USN, for working the historical retrospective articles through your commands and for connecting us with your historians. Thank you to Col. Ken Franz, USMC (Ret.), and the Marine Corps Engineer Association for taking on authoring the Marine Corps engineering article. All of you and many others were always gracious with our requests and we could not have put this magazine together without your assistance. Thank you as well to our advertising supporters who have made publishing this issue financially possible. Your commitment to SAME and our national security is unwavering. And lastly, thank you to the SAME members who took the time to submit personal stories about your service "in country." Because of all of you, we were able to tell *our* unique story and add to the great engineer legacy captured in the annals of Vietnam for future generations.

We decided there were two unique ways that we could tell our story: one, through first-hand accounts published in *The Military Engineer* during the 1960s and early 1970s; and two, through the memories of our members—those who were there in Vietnam.

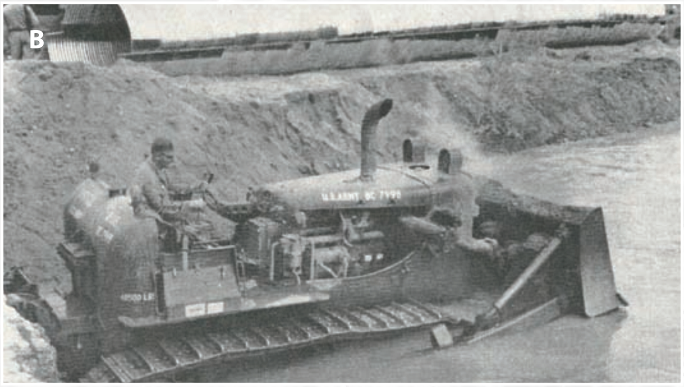
As you can imagine, there is only so much that can fit in one magazine. Much, unfortunately, had to be left "on the cutting room floor." There was an immense amount of content that appeared in *TME* during the 1960s and early 1970s relating to engineering in Vietnam. Only a fraction of it we were able to re-publish here. Operations in Thailand, also, were an integral part of the Vietnam War efforts and were documented in the past issues. For space reasons, those stories were omitted here.

Ultimately, the journey in putting this issue together has been one of enjoyment, and one of sober reflection. Enjoyment, because reading about the engineering accomplishments of our fellow military engineers is inspiring; the work they did in the swamps and jungles and mountains and ports and rivers and bridges and tunnels and airfields of Vietnam was truly incredible. Sober reflection, meanwhile, is the bittersweet reality of sacrifice.

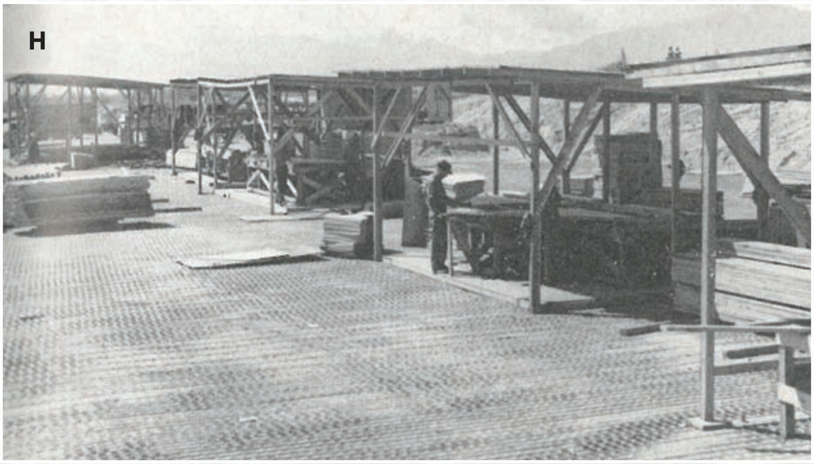
We hope you, too, enjoy the *TME* Vietnam Commemorative Issue—and also give pause, as you reflect on the sacrifices and triumphs of those who served then, those serving today, and all those (men and women, civilians, contractors and servicemembers) who have fought for freedom throughout our nation's history.

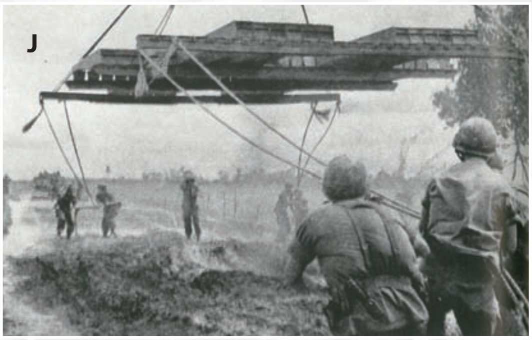
Brig. Gen. Joseph Schroedel, P.E., F.SAME, USA (Ret.)
SAME Executive Director & Publisher, *The Military Engineer*

Engineers in Action



A. Preparing for Swimmer Support Boat Operations Against the Guerrillas in the Mekong Delta (1964) **B.** Preparing the Culvert Bed (1967) **C.** Patrol Tracking a Tunnel Rat with Mine Detector (1967) **D.** Bailey Bridge along the Route (1967) **E.** Warily Disarming a 30-pound Land Mine (1967) **F.** Mine Sweeper in the Lead (1969) **G.** Landing and Start of Clearing (1968). PHOTOS & CAPTIONS FIRST PUBLISHED IN THE MILITARY ENGINEER'S "MILITARY ENGINEER FIELD NOTES" IN THE YEAR NOTED





H. & I. The Prefab Mill at Hue Phu Bai; Work with Pneumatic Nailer (1966) **J.** Pulling against Updraft of the Flying Crane to Lower Bridge Span (1970) **K.** Carrying Balk into Position on Bridge Frame (1971) **L.** Bridge Construction on Route 9 (1972) **M.** Completed Pipe Sections on Floats (1971).

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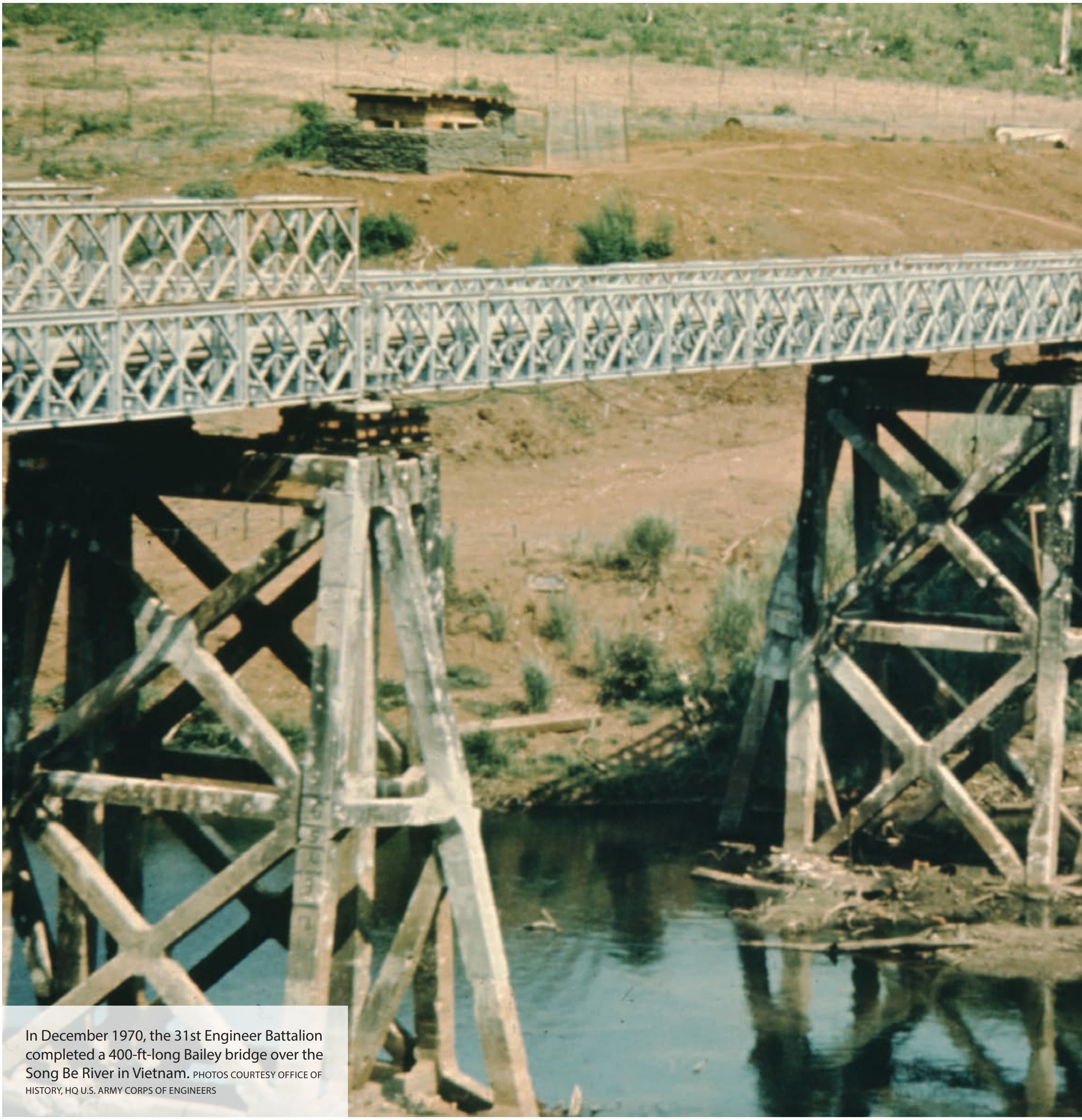
DUTY AND PURPOSE

Army Engineers in Vietnam



In December 1970, the 31st Engineer Battalion completed a 400-ft-long Bailey bridge over the Song Be River in Vietnam. PHOTOS COURTESY OFFICE OF HISTORY, HQ U.S. ARMY CORPS OF ENGINEERS

U.S. Army engineers arrived in force to the Republic of Vietnam, more commonly known as South Vietnam, in 1965 and soon numbered more than 40,000 officers and men. Immediately, the engineers found themselves in an underdeveloped country working and fighting in frequently brutal weather in harsh terrain, under constant threat from an elusive and determined foe.

Lt. Gen. Carroll Dunn, USA, would later describe the conditions in Vietnam succinctly:

> *Formidable obstacles confronted the engineers. The tropical climate, with its monsoon rains and enervating heat, imposed severe handicaps on constructors. Few building materials, either natural or manufactured, were available locally. Saigon was the only deep-draft port. Roads, mostly primitive, were interdicted by the enemy. Cargoes had to move in coastal vessels or by air. The supply line to the United States stretched ten thousand miles. Native labor was largely unskilled. Because much of the country was thickly populated and graves of venerated ancestors abounded, building sites were at a premium. Complicating the entire construction program was the use of essentially peacetime funding methods in a war situation.*

Initially, the ports of Da Nang, Cam Ranh Bay, and Saigon were considered to be sufficient to receive logistics from the United States. Engineers improved capacities by building ports and depots for the logisticians, carving airstrips out of jungles and mountains, repairing or building roads and bridges for advancing troops and supply convoys, and constructing bases to meet the needs of an expanding military complex. Engineers also helped the people in a war-ravaged country with countless civic action projects and trained South Vietnamese engineers on newer equipment.

In the field, Army engineers cleared roads of mines and obstacles; explored and destroyed enemy tunnels; cleared land of vegetation and jungle to deny the enemy cover; and fought as infantry when needed.

THE BUILD-UP

Before 1965, American construction capability in the country was limited to a small civilian workforce under contract to the U.S. Navy. Under Defense Department regulations, the Navy's Bureau of Yards and Docks—and not the U.S. Army Corps of Engineers—was responsible for Southeast Asia. As the build-up of U.S. troops gained momentum, existing base development

This Rome plow unit, one of the first six to be used in Vietnam, clears vegetation from the maintenance and supply area in the Long Binh complex, November 1966.

plans fell short as a large numbers of soldiers deployed. Initially, the rapid build-up did not include enough engineers to handle the myriad of support facilities needed. As a result, heightened involvement of Army engineers was a reaction to the dramatic upsurge of U.S. forces rather than the execution of specific base development plans. Soon, demand for engineer support outpaced the availability of trained and readily deployable engineer units. Contractors and civilian workers filled the void.

President Lyndon Johnson's decision in November 1965 not to order a general call-up of Reserve and National Guard units, which contained the majority of troop construction units, severely limited the Corps of Engineers' ability to meet construction requirements and increased reliance on contractors and locally procured labor. For the first time, civilian contractors and workers assumed a major construction role in an active theater of operations.

Meanwhile, the war went badly for the South Vietnamese. Viet Cong main forces and guerrillas, steadily increasing in numbers and effectiveness, systematically bled Saigon's forces in large and small engagements. U.S. troop deployments once again accelerated and included troops from Australia and South Korea. By mid-June 1966, new military leaders took control of the shaky Saigon government. The United States realized that the new government would need even more U.S. combat troops to help stem the tide. President Johnson authorized deployment of three additional U.S. Army divisions with their engineer companies and five additional engineer battalions. The engineers' combat and operational support role grew. They enabled arriving tactical units to defend key bases and to launch large-scale offensive operations. They built forward combat bases and constructed airfields.

ORGANIZATION IN THEATER

In the summer of 1965, as more engineers arrived in South Vietnam, the need to deploy an engineer brigade headquarters became apparent. The newly activated 18th Engineer Brigade, under the command of Brig. Gen. Robert Ploger, USA, provided command and control. About this time, the Department of Defense decided that the expanding construction program, which increasingly depended on Army, Navy, and Air Force contractors such as Pacific Architects and Engineers (PA&E), DeLong Corp., Vinnell Corp., and the large joint venture of Raymond International and Morrison-Knudson and Brown & Root and J.A. Jones (RMK-BRJ), also needed tighter control.

In February 1966, Gen. William Westmoreland, Commander of Military Assistance Command, Vietnam (MACV), established a Construction Directorate and put then-Brig. Gen. Carroll Dunn, an engineer general officer, in charge as the first Director of Construction. Gen. Dunn oversaw the entire construction program and assumed control of the advisory effort for the South Vietnamese Army engineers.

Later that year, MACV added an engineer command under Gen. Ploger to supervise one engineer brigade, two groups, and nearly all the non-divisional engineer units in Vietnam.

BUILDING THE BASES, 1966-1968

Throughout 1966, planning and construction focused on developing major deep-draft ports and nearby roads and airfields to improve delivery, storage, and distribution of materiel. To improve access to South Vietnam's ports, a fleet of dredges, including the *Davison* and the *Hyde* from the Corps of Engineers' Civil Works fleet, cleared waterways and deepened channels. Army engineers also constructed much of South Vietnam's highway system. Overall, engineer troops constructed roughly 900-mi of modern, paved highways, connecting the major population centers, and also monitored the construction of an additional 550-mi of Vietnamese highways by American contractors. The work, collectively, has been called "the single most effective and important development program undertaken by the American effort in Vietnam."

Various technological innovations developed by the Corps' research laboratories aided the Army engineers in airfield construction. To combat the thick mud that could quickly disable tactical airfields in the monsoon season, engineers employed the T-17 membrane, a neoprene-coated fabric used to cover the airfields and provide them with an impermeable "raincoat." Another problem was reduced vision of helicopter pilots and additional wear on helicopter rotors caused by the abrasive dust stirred up by flight operations. The Corps' research laboratories had been using Peneprime, a dust palliative with an asphalt base, as a penetrant in Civil Works projects. When an assessment team determined that this agent also was appropriate for battlefield use, Army engineers sprayed Peneprime onto heliport sites to prevent dust clouds from interfering with helicopter operations.

By the end of 1968, bases were fully functional. With operations anticipated to continue for the duration, the Army decided to upgrade troop housing from tents to tropical wood-framed buildings and to install better utilities beyond the designs called for in technical manuals.

Members of D Company, 35th Engineer Battalion, sweep for mines on Route 1 near Bong Son in April 1967. Nearly 30-mi of road were swept each morning prior to beginning construction work.

COMBAT SUPPORT

During operations, U.S. forces often came across enemy base areas containing vast networks of bunkers and tunnels. Specially trained combat engineer teams searched the tunnel complexes for prisoners, equipment, and documents. The "tunnel rats" found large complexes, especially north of Saigon. Some had as many as four distinct levels that held quarters, hospitals, mess facilities, and even areas for manufacturing and storing war materials. The work was, in short, extremely dangerous.

Land clearing was another effective weapon against the Viet Cong insurgency. Guerrilla forces used thick forests along the nation's major transportation routes to conceal themselves before laying mines or staging ambushes. Consequently, engineers had to clear all vegetation up to 100-yd on either side of major roadways. Finding bulldozers and flammable napalm unequal to the task, in 1967, the engineers introduced the Rome plow, a military tractor equipped with a protective cab and a special tree-cutting blade that was sharpened daily. The Rome plow was used to cut trees at or near ground level; it also had a stinger to split longer trees. A land-clearing engineer company equipped with 30 Rome plows could clear 180- to 200-acres of medium-density jungle each day.

At the end of January 1968, the war reached a critical stage when Hanoi launched its Tet Offensive throughout South Vietnam. Before the offensive petered out in March, operational support missions absorbed two-thirds of Engineer Command's capacity. By April, most of the roads had been reopened and the bridges repaired, which allowed a majority of engineer units to return to a more typical allocation of effort between construction and combat support.

GRADUAL WITHDRAWAL, 1969-1973

The year 1969 ushered in a new administration under President Richard Nixon and with it a new direction of American policy in Vietnam. The United States committed itself to gradual withdrawal of its forces from an unpopular war and to turning over greater responsibility to the South Vietnamese. In both Saigon and Washington, D.C., planning began in earnest for the execution of a "Vietnamization" concept, which included accelerated training of the Vietnamese to take over more operations.

The military construction program was now more than 75 percent completed. Engineer troops and contractors had built six deep-water ports and shallow-draft facilities at nine other locations. Mooring buoys and unloading facilities discharged fuel, and pipelines distributed it to major bases. Eight jet-capable air bases with 15 10,000-ft concrete runway/taxiway systems and parking aprons were in service, supplemented by 83 auxiliary airfields capable of handling C-123 or C-130 cargo planes.

As combat forces continued to withdraw, Army engineers placed more emphasis on training South Vietnamese Army engineers. The South Vietnamese Engineer School tripled its student capacity to 3,000 and more officers and enlisted men were sent to the U.S. Army Engineer School at Fort Belvoir, Va. By the end of 1969, U.S. Army Engineer Command, Vietnam, had about 26,000 troops.

Between 1971 and 1973, American and allied forces completed their withdrawal from Vietnam and signed the Paris Agreement, effectively ending the war. For Army engineers it was a time of wrapping-up its part of the construction program, making headway on highway improvements, transferring facilities and responsibilities to the South Vietnamese, and providing combat operational

1st Lt. William Gang of the 168th Engineer Battalion's Land Clearing Team, "The Jungle Eaters," kneels next to an opening of a tunnel complex discovered in the Iron Triangle during Operation Atlanta, December 1967.

support to the dwindling ground forces. Among the last major operational support missions for Army engineers were building large firebases along the approaches to the U.S. bases protecting the Saigon and Da Nang military complexes.

In April 1972, the Engineer Command was replaced by a smaller U.S. Army Engineer Group, Vietnam, then down to under 1,000 troops. Augmented with Vietnamese laborers and facilities engineering contractors, it provided limited operational support and minor construction and facilities engineering services.

The winding down of the construction program also saw the phasing out of the nearly $2 billion contract with RMK-BRJ. In 11 years, the firms accounted for more than 60 percent of the construction in Vietnam—they built MACV headquarters, much of Long Binh Post, and five major bridges; handled major airfield, port, depot, cantonment, and highway work; and employed and trained over 200,000 Vietnamese men and women.

At its peak, Army engineer troop strength in Vietnam approached 40,000 soldiers, augmented by tens of thousands of contractors.

CONCLUSIONS FROM VIETNAM

The U.S. military effort in Vietnam required a massive construction effort. Army engineers, supported by a large contractor workforce, built facilities, warehouses, piers, troop cantonment areas, maintenance facilities, roads, bridges, and airfields. At its peak, Army engineer troop strength in Vietnam approached 40,000 soldiers, augmented by tens of thousands of contractors. The presence of so many construction contractors was a notable innovation. It marked the first time civilians assumed a major construction role in an active theater of operations.

The construction program in South Vietnam did not evolve from any single planning action; rather, it developed from immediate requirements in 1965 and expanded as needs increased. According to Gen. Dunn, one of the chief lessons learned was "that the requirements for facilities engineering support in future conflicts must be anticipated during contingency planning, inasmuch as these requirements represent a substantial portion of the resources required." He insisted this lesson also be applied to land-clearing equipment, mine detectors, and road construction equipment.

Working near or with combat troops, Army engineers, particularly, combat engineers, faced danger. This was especially true clearing mines, opening roads, clearing jungle in Rome plows and bulldozers, and supporting combat troops. By the nature of their work, engineers became vulnerable to enemy assaults and accidents. More than 1,500 soldiers (engineers and non-engineers) including 143 officers were killed or died of injuries while serving in engineer units or performing engineer assignments.

The last Army engineer units departed South Vietnam before the end of 1972.

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Bianka J. Adams, Ph.D., is an Historian with the Office of History, HQ U.S. Army Corps of Engineers; bianka.j.adams@usace.army.mil.

Matthew T. Pearcy, Ph.D., and Douglas J. Wilson assisted in the research for this article.

See page 126 for article sources and suggested further reading.

U.S. Air Force photo by Airman 1st Class Adarius Petty/Released

BUILDING RESPECT
Air Force Civil Engineering in Vietnam

U.S. Air Force civil engineering came of age with the challenges and opportunities afforded expeditionary engineers during the Vietnam War. As American military involvement increased to shore up the South Vietnamese government in the early and mid-1960s, the requisite construction demand stretched the capacity of the U.S. Army Corps of Engineers and Naval Construction Battalions to the breaking point. Housing, mission support, and airfield work throughout the Republic of Vietnam required construction capacities beyond what was available in theater by 1965.

In order to meet sortie rate and mission requirements, airfields were accommodating increased numbers of personnel, jet fighters and heavy air transport aircraft with facilities and runways that were not suitable for this operational pace. The Rapid Engineer Deployable, Heavy Operation Repair Squadron, Engineering, (RED HORSE), rode in to the rescue, providing an initial stop-gap solution with a legendary "Can do … Will do" esprit de corps that has echoed throughout the Air Force to the present day.

Prior to the arrival of RED HORSE, the Air Force had no capability to build an airfield from the ground up. In fact, the Air Force lacked this capacity since inception in 1947. The agreement that mapped out the separation of the Air Force from the Army directly stated: "the Army is designated as the contract construction agent for the Air Force. The Air Force will provide funds for such construction, will collaborate in the preparation of specifications … and will review and approve contracts prior to awards. Design of specialized technical facilities for Air Force use will be the responsibility of the Air Force."

IDENTIFYING A NEED

From 1947 through 1965, the Air Force depended upon the Army Corps of Engineers and Naval Construction Battalions to provide construction support in contingency operations. This cumbersome inter-service arrangement proved to be a considerable challenge in overseas contingencies, requiring Air Force civil engineering support from Korea to Lebanon over the course of the 1950s. The operational difficulties experienced in Air Force civil engineering support for Operation Bluebat (Lebanon, 1958) provided the genesis for an idea that eventually evolved into the development of Prime Base Engineer Emergency Force (BEEF) and RED HORSE seven years later.

In July 1958, President Dwight Eisenhower sent a contingent of U.S. Marines and Army paratroopers into Lebanon in what became known as Operation Bluebat in support of the Lebanese government's suppression of political unrest. As Marines came ashore securing the airport at Beirut, Army soldiers stationed in Europe prepared to embark on Air Force transport aircraft proceeding to Beirut by way of Adana, Turkey.

Incirlik AB in Turkey proved woefully inadequate to provide for the transitory arrival of thousands of Army personnel with the civil engineer functions of base maintenance and repair executed by a reduced crew of civilian contractors. U.S. Air Forces in Europe (USAFE) recognized this shortfall and alleviated a potential crisis by deploying active-duty civil

Early airfield construction at Tuy Hoa, Republic of Vietnam, in 1966, with equipment and supplies brought in over the beach. In just one year's time, airmen engineers transformed isolated real estate to the fully operational Tuy Hoa AB. U.S. AIR FORCE PHOTOS

engineering support teams from personnel assigned to bases throughout its area of responsibility. Following Operation Bluebat, USAFE established Civil Engineer Mobile Teams from personnel already stationed in theater. These teams consisted of flexible detachable cells able to provide tailored emergency operational and maintenance support at forward operating bases during contingencies. Fast reaction, highly mobile civil engineering teams provided only essential operation and maintenance capabilities with no heavy construction capability since it was assumed this would be provided by Army construction battalions. USAFE designed these teams to establish and maintain essential utilities and facilities operations in a contingency environment until relieved or augmented by additional forces.

By 1964, this concept was adopted Air Force-wide with the development of mobile Prime BEEF teams responsible for airbase recovery, contingency, missile, logistics and support, engineering assistance, and fly-away. Even with the development of these capabilities, the Air Force still lacked the capacity to provide overseas heavy construction support under operational conditions. Nevertheless, Prime BEEF moved the Air Force even closer to a capability that would eventually develop into RED HORSE during a particularly challenging contingency: South Vietnam.

A WAR TAKES HOLD

The Republic of Vietnam faced daunting foes with an internal communist insurgency fueled by a hostile neighbor to the north. North Vietnam not only provided material support to communist sympathizers in the south (colloquially known as Viet Cong), but regular North Vietnamese Army personnel regularly violated the borders of South Vietnam in support of Viet Cong advances.

To stem the "red tide" threatening to engulf all of Southeast Asia, President Lyndon Johnson deployed increasing numbers of American military personnel beginning in 1964. Significant numbers of airmen, soldiers, sailors and Marines began arriving under Military Assistance Command, Vietnam in support of on-going security actions and Operation Rolling Thunder (an aerial bombing campaign initially designed to punish North Vietnam following hostile actions against the U.S. Navy in the Gulf of Tonkin). Rolling Thunder and aerial bombardment would eventually evolve into a series of operations calculated to forcefully coerce the North Vietnamese to the negotiating table and an end to hostilities.

(Top) A RED HORSE crew operates quarry equipment at Tuy Hoa AB, South Vietnam, in 1966. (Bottom) Airmen with Prime BEEF pour concrete for the floor of a building at Tan Son Nhut AB in South Vietnam.

As described by a wing commander in South Vietnam: "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."

For Air Force civil engineering, the conflict between North and South Vietnam mirrored the experience of the Korean Conflict with dependence upon Army and Navy construction and contracting support in the early years of the American presence in Southeast Asia. But two significant differences emerged between the Korean and Vietnamese conflicts: one, the deployment of Prime BEEF teams; and two, an inquisitive Secretary of Defense.

These two differences contributed to the coming of age for Air Force civil engineering during the Vietnam War.

The increase in American personnel and aircraft throughout South Vietnam following the Gulf of Tonkin incident required a requisite buildup in facilities to house and maintain incoming forces. Starting in 1965, the Air Force employed Prime BEEF teams to augment overworked in-country civil engineers by improving air fields and installing upgrades to allow World War II-era runways to accommodate the faster, heavier modern jets of the 1960s. According to Col. Henry Stehling, Pacific Air Forces Director of Civil Engineering, "The lack of [Air Force] civil engineer resources in-country at the time … and the urgent requirement to provide immediate facilities for the rapid buildup of tactical units in Southeast Asia, provided the necessity and challenge for proving the Prime BEEF concept."

Prime BEEF teams effectively met the challenge in Vietnam—building barracks, erecting revetments, establishing essential utilities, providing general construction support and repairing runways. Yet still, the Air

Members of the 820th Civil Engineer Squadron RED HORSE belt together panels of galvanized steel to make an arch for an aircraft shelter under construction at Da Nang AB in South Vietnam, October 1968.

Force could not independently build a complete airbase from an undeveloped site. This fact became painfully evident when Secretary of Defense Robert McNamara pointed out to Secretary of the Air Force Eugene Zuckert that the Navy and Marine Corps planned to build a completely new airfield near Chou Lai, Republic of Vietnam, in only 28 days. Secretary McNamara asked if the Air Force had a similar capability. The answer was that no, the Air Force could not build an airfield from scratch at that time.

This capability gap would soon be overcome. Within nine months, "a quick-reacting, heavy repair force, organic to the Air Force" was planned, developed, manned, trained and deployed to Phan Rang, South Vietnam: the 554th Civil Engineer Squadron (CES). Selected volunteers from civil engineering units throughout the Air Force constituted the first RED HORSE squadrons in the 554th CES, 555th CES, 819th CES, 820th CES and 823rd CES that served with distinction throughout South Vietnam. Beginning in February 1966 the Air Force deployed for the first time self-sufficient civil engineering squadrons with the capability "to place expeditionary airfields and supporting facilities into operation." The mission that spotlighted Air Force civil engineering capabilities in building up an operational airfield from nothing fell to the 820th CES at Tuy Hoa, South Vietnam.

START OF A LEGACY

Airfield construction at Tuy Hoa proved that Air Force civil engineers could construct a contingency base when necessary and would no longer need to rely completely upon the construction and contracting support provided by the Army and Navy. From beginning to end, Air Force civil engineers controlled the construction of Tuy Hoa under contract with Walter Kidde Constructors Inc.

Innovative contracting and construction brought Tuy Hoa into operation six weeks before the completion deadline. As described by a wing commander in South Vietnam: "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."

Ringing testimonials and solid airfield construction throughout South Vietnam set the legacy for RED HORSE squadrons that have supported contingency operations from Southeast to Southwest Asia. From Tuy Hoa to Tikrit, Iraq, and everywhere in between, RED HORSE squadrons have provided the engineering foundation from which the Air Force projects air power.

"Can do … Will do" continues to ring true today as the mantra enabling American airmen around the world to "Fly, Fight, and Win."

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Andrew Billman is an Historian with the Air Force Civil Engineer Center and the Air Force Installation & Mission Support Center, Joint Base San Antonio-Lackland; andrew.billman@us.af.mil.

See page 126 for article sources and suggested further reading.

"WE BUILD, WE FIGHT"
The Naval Construction Force in Vietnam

Seabees with Naval Mobile Construction Battalion 7 build a shower facility in Phu Bai, Republic of Vietnam, 1966. U.S. NAVY PHOTOS

"Today's lesson learned must be tomorrow's method of operation if we are to survive as human beings or as an effective Seabee construction/fighting force."
—Naval Construction Forces Manual, 1969

U.S. Navy engineers oversaw a tremendous amount of work in building a viable public works infrastructure during the Vietnam War. In 1963, the Bureau of Yards and Docks (BuDocks)—which became Naval Facilities Engineering Command (NAVFAC) in May 1966—was formally designated as the contract construction agent for Southeast Asia and responsible for nearly all U.S. construction there. This included facilities built for the U.S. Army, U.S. Air Force, and other federal agencies. Throughout the course of the war, BuDocks/NAVFAC managed more than $2 billion worth of construction efforts in Vietnam. It was at the time the largest single effort of military construction ever executed.

Private contractors performed the majority of the work under contracts managed by Civil Engineer Corps (CEC) officers. BuDocks/NAVFAC also managed the Naval Construction Force, which built and maintained U.S. military bases throughout Vietnam. The requirement for construction of facilities for both bases and tactical missions increased as the number of the American troops in South Vietnam escalated.

To meet this increased demand, the Naval Construction Force doubled in size between 1965 and 1967. The force size grew so quickly that it exposed the management shortfalls of the Seabee program at all levels.

In an effort to correct these shortfalls, in 1966, NAVFAC conducted a self-analysis, which resulted in circulating a list of lessons learned that would shape how the Naval Construction Force engaged in the latter part of the war—lessons that in many ways have extended from World War II through Vietnam, to Iraq and Afghanistan and other contemporary operations around the globe.

ENSURING A READY FORCE

The Navy's civil engineering program always has been under the administrative control of NAVFAC and its predecessors dating back to the early 19th century.

World War II brought the establishment of Navy construction battalions, better known as the Seabees. During the war, some 325,000 men served as Seabees. An entirely reserve force, most had professional construction experience. CEC officers served as the commanding officers of the newly formed battalions. Senior leadership within BuDocks worked closely with the private sector—unions and commercial equipment suppliers—to ensure the Navy had the personnel and tools required. The CEC also mobilized rapidly by expanding its reserve program. By August 1945, there were more than 10,000 Reserve CEC officers in uniform.

Like the rest of the American military, the Seabees were quickly demobilized after the war. Despite funding cutbacks, leadership

Seabees with Naval Mobile Construction Battalion 128 lay the cornerstone at a children's hospital as part of a civic action project in Da Nang during a 1969 deployment to Vietnam.

acknowledged the strategic value of maintaining active duty construction battalions and officially converted them into permanent units in 1947. As a complement to the active duty force, the Seabee Reserve Program was formally organized in July 1948.

By June 1950, there were 224 Seabee units, each consisting of four officers and up to 50 enlisted men at Naval Reserve Training Centers across the country ready to be expanded into full-size battalions in the event of an emergency. Although the regular active duty strength of the Seabees reached a low of 3,400 in the late 1940s and stayed relatively low, the numbers of Seabee Reserve personnel mushroomed throughout the 1950s. By 1960, the total Reserve Seabee force strength stood at more than 13,000.

SERVING IN SOUTH VIETNAM

Seabees served in support of some of the earliest American joint operations in South Vietnam. They first arrived in Vietnam in August 1954 in support of Operation Passage to Freedom, assisting with the relocation more than 300,000 Vietnamese civilians, soldiers and non-Vietnamese members of the French Army from communist North Vietnam to South Vietnam. In 1957, in conjunction with the United States Operations Mission, Seabees assisted the South Vietnamese government with a land development program that relocated families, including both South Vietnamese locals and refugees, from overcrowded camps and villages to more rural, undeveloped mountainous areas of the highlands.

As a result of the expansion of American counterinsurgency efforts in the early 1960s, the Navy developed the Seabee Team Program. The program serves as perhaps the most significant operational "lessons learned" by the Seabees during the Vietnam War.

From 1963 to 1965, Seabee Teams served in support of the South Vietnamese government under the simultaneous sponsorship of the U.S. Agency for International Development and the Department of Defense. Teams built U.S. Special Forces camps in remote areas in South Vietnam for the Army and provided construction support to economic and social projects. During nine year serving "in-country," 128 Seabee Teams deployed to 62 sites throughout South Vietnam. While the formal program was discontinued in 1972, the Naval Construction Force has had a version of the Vietnam-era Seabee Team deployed around the globe ever since.

The tempo of Vietnam changed drastically in 1965. The United States rapidly increased its military forces, prompted by the realization that the South Vietnamese government was losing the war as the communist-dominated Viet Cong gained influence over much of the population in rural areas of the country. The requirement for more American boots on the ground created the demand for a more robust and modern public works infrastructure throughout the country.

Seabees began deploying on regular rotations in early 1965. There were approximately 9,500 Seabees and 1,650 CEC officers on active duty around the world. Roughly 5,700 were assigned to one of 10 Naval Mobile Construction Battalions (NMCB) or two Amphibious Construction Battalions. The initial mission was to construct tactical facilities in remote areas in support of the U.S. military's comprehensive "enclave strategy," which gave Seabees the task of establishing bases around key coastal areas with authorization to assist the South Vietnamese military up to 50-mi from the base perimeters in combating Viet Cong forces.

One of the more extraordinary engineering projects was the airfield at Chu Lai. From May 7 to July 3, 1965, NMCB 10 overcame multiple obstacles to construct an 8,000-ft expeditionary airfield. The Short Airfield for Tactical Support required at Chu Lai was effectively a carrier flight deck made from AM-2 aluminum slab matting and then fitted with the necessary landing/take-off gear. Because of the immediate need for this airfield, the soil samples taken by the reconnaissance party were ignored. The fine sand of Chu Lai was too soft to withstand the weight of the airfield, so although planes were able to land on it just 14 days after starting construction, the airfield was deconstructed in order to regrade and compact the shifting sands of Chu Lai.

Seabees also were charged with constructing and maintaining the public works infrastructure of bases and camps. In 1965, Seabees laid the groundwork for three major advance bases in the northern provinces of South Vietnam at Da Nang, Phu Bai and Chu Lai, and during 1966 and 1967, continued to expand them to meet growing demand.

FORCE STRENGTH GROWS

In July 1965, the Chief of Naval Operations authorized the establishment of four additional Seabee battalions to help meet the facility needs of the additional troops arriving in Vietnam. Finding unskilled construction men was not difficult. But unlike in World War II, finding enough skilled petty officers did pose a challenge. To mitigate this problem, BuDocks directly recruited skilled construction workers as petty officers into the Seabees. BuDocks received union support and gained 4,950 "instant petty officers" in 1966 and another 10,000 in 1967.

The CEC faced a similar personnel shortfall. Although many young college graduates with engineering degrees sought commissions into the CEC hoping to avoid the draft, there were still not enough officers to fill all available billets, especially at the lieutenant and lieutenant commander levels. In 1967, the CEC announced a program for direct appointment of about 200 civilian engineers to middle-grade positions. Applicants had to be graduate engineers between the ages of 26 and 38 with five to 12 years of experience. This appointment program was the first time the CEC had attempted to obtain middle-grade officers directly from civilian life since World War II.

In early 1966, U.S. military personnel in South Vietnam totaled 185,000. By the end of the year, another 382,000 men had been drafted into service, the highest total during the Vietnam War. From late 1966 through 1967, Seabee efforts in Vietnam continued to expand. Up to this point, they had built three major airfields, cantonments to house more than 200,000 troops, and storage for a capacity of 200,000 barrels of oil. They also had provided enough rock from their crushers and quarries to build an imaginary wall 8-ft high and 1-ft thick along all of the South Vietnam borders with North Vietnam, Laos, and Cambodia. The construction outlook for subsequent years was even greater as American involvement in Vietnam grew deeper in the late 1960s.

Camp Hoover in Da Nang, Republic of Vietnam, 1968.

IMPLEMENTING LESSONS LEARNED

In 1967, the Department of Defense and the Navy conducted several lengthy studies on the efficiency of the construction programs being implemented with respect to restoring roads and opening the lines of communication throughout South Vietnam. The primary study was done by Air Force Brig. Gen. Daniel Raymond, who served as Theater Engineer for Military Assistance Command, Vietnam, and acted as the "construction czar" for U.S. Forces from 1966 to 1967.

The Joint Chiefs of Staff established a Special Military Construction Study Group to review the issues raised and ultimately their recommendations were approved and put into effect in 1969. Each branch of the service staffed the construction issues, publishing its own analysis. The "Navy Analysis" produced a significant number of lessons learned, most of which applied to NAVFAC. In turn, NAVFAC prepared its own analysis, aptly titled "NAVFAC Analysis," which resulted in the initiation of several long-term actions that changed its approach in Vietnam.

Perhaps the most transformative change was the preparation of NAVFAC foundational documents for both Seabees and Officers in Charge of Construction

Personnel from Delta Company, Naval Mobile Construction Battalion 128, plow through a rice paddy as they set fence posts at Ammunition Supply Point #1, Da Nang, Vietnam. Delta Company provided perimeter security in the form of a 6-mi chain link fence that was put up over terrain that varied from rice paddies to the sheer slope of a rocky hillside.

(OICC). In 1969, NAVFAC published the "Naval Construction Forces Manual" to provide uniform doctrine, concept of operations, and resources to all Seabee units. NAVFAC also published a construction plan and guidelines for OICCs operating in a contingency or limited war situation. It included a succinct organization definition, a listing of equipment and materials, and standard operating procedures. With this planning and documentation in place, both Seabee units and OICCs could focus on the expanded wartime workload in Vietnam, rather than reinventing internal organization, process, and procedure.

Another change was the rewrite of the BuDocks Manual for the Administration of Cost Plus Fixed Fee contracts. Unlike in World War II, the situation in Vietnam allowed for civilian construction workers "in-country." The old manual, NAVDOCKS P-274, gave contractors the responsibility for accounting and property management, which did not serve the ever-changing construction requirements of wartime. The lesson learned from Vietnam was that the supported commands had the best appreciation for the entire project and a greater motivation to maintain accountability. The new four-volume manual defined the relationship between the government and the contractor, and focused on the total management of the contract, not just the accounting.

The basic framework of the new manual was underpinned by the level of effort concept, which prioritized the construction program based on the size and complexity of the project. By balancing the work load, capability, and funds equally across all reimbursable projects, it ensured work being assigned to NAVFAC was prioritized equally.

LOOKING BACK AND FORWARD

The number of Seabees in Vietnam peaked in 1968. By autumn that year, worldwide Navy engineering strength had grown to more than 26,000 Seabees and 2,200 CEC officers, serving in 21 full-strength Naval Mobile Construction Battalions, two Construction Battalion Maintenance Units, and two Amphibious Construction Battalions. All of the newly commissioned and activated Seabee Reserve units were formed based on the same uniform guidance provided by the new Naval Construction Forces Manual, making battalions effectively modular components and offering greater strategic versatility to the Navy. This not only simplified the logistics of battalion turnover, but the interchangeability made it possible for battalions to assign detachments of specifics ratings and skill level. The Construction Battalion Maintenance Units were commissioned to maintain larger bases in Da Nang and Cam Ranh Bay, freeing up the battalions to send detachments to more remote areas. Between 1969 and 1972, the Seabees deployed all over South Vietnam in support of U.S. construction projects, including the construction of floating bases compromised of AMMI pontoons in the Mekong Delta.

The last Seabee battalion departed Vietnam on Nov. 7, 1972. The hard fought lessons learned in Vietnam, and drawing on the experiences from World War II, not only shaped how Seabees performed then, but also influenced how NAVFAC and the Seabees fought the wars in Iraq and Afghanistan. During Operation Iraqi Freedom/Operation Enduring Freedom, roughly 15,000 Seabees served in Iraq and Afghanistan. Like in World War II and Vietnam, Seabee Reserve units were activated in response to the requirement for an expanded Naval Construction Force. NAVFAC and the Naval Expeditionary Combat Command organized expeditionary mobilization centers in the active Seabee homeports where the infrastructure for supporting the in-processing and training of personnel already existed.

With the engagement winding down in Iraq and Afghanistan, now is the time to collect the lessons learned to add to the Seabee legacy, which will unequivocally improve how NAVFAC and the Naval Construction Force support U.S. strategic objectives in the future—just as they did in Vietnam.

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Lara Godbille, Ph.D., is Director of the U.S. Navy Seabee Museum; lara.godbille@navy.mil.

See page 126 for article sources and suggested further reading.

MARINE CORPS ENGINEERS in Vietnam

While the Beatles flooded radio airwaves in 1965 and the Beach Boys were belting out tunes to young Americans who were twisting the night away, other young men were receiving their draft notices to fill the military ranks. These men were getting ready to go to battle against insurgents in Southeast Asia, and a place many had not heard of. Vietnam had been in the news for several years, but many young men did not pay attention to what was being said until they were notified they were being drafted.

The U.S. Marine Corps has always recruited men who have a "We Can Do It" attitude. Engineers epitomized that, working hard to build roads, helicopter landing pads, schools, and bases to house the influx of Marines into Vietnam.

Marine Corps engineers first arrived in Vietnam in early 1965, when C Company, 7th Engineer Battalion was sent to Da Nang to support a Light Anti-Aircraft Defense Missile Battery, then began arriving in mass with the landing of the 9th Marine Expeditionary Brigade. The austere infrastructure of Vietnam made the war a truly "Engineer's War" as no unit could perform its basic mission without engineer support.

- Division Engineer Battalions (about 850 Marines) provided demolition support, road clearing operations often with handheld mine detectors, and "pioneer trails" to support the infantry's mobility.
- Force Troop Engineer Battalions (also about 850 in strength but with much more equipment) improved roads and built fire bases, generally improving the condition of the Marines in country.
- Air Wing Engineers (Marine Air Base Squadrons or Marine Wing Support Group—about 350 engineers) built or improved the conditions at airfields so much needed air support could be provided to troops engaged in combat.

The difference in the deployment of engineers in Vietnam over modern operations is the units stayed in country while Marines deployed in to fill 13-month tours of duty. At the height of Marine combat in Vietnam there were five Marine Corps Engineer Battalions "in country" during 1966-1969.

DIVISION ENGINEER BATTALIONS

1st Engineer Battalion deployed from Camp Hanson, Okinawa, to Chu Lai, in January 1966 until January 1971 where the unit participated in operations in and around Chu Lai and Da Nang. The battalion received Vietnam Service Streamers for 1966-1967 and 1967-1968. Providing a variety of close combat engineer support throughout I Corps, the battalion also took part in the battle for Hue City.

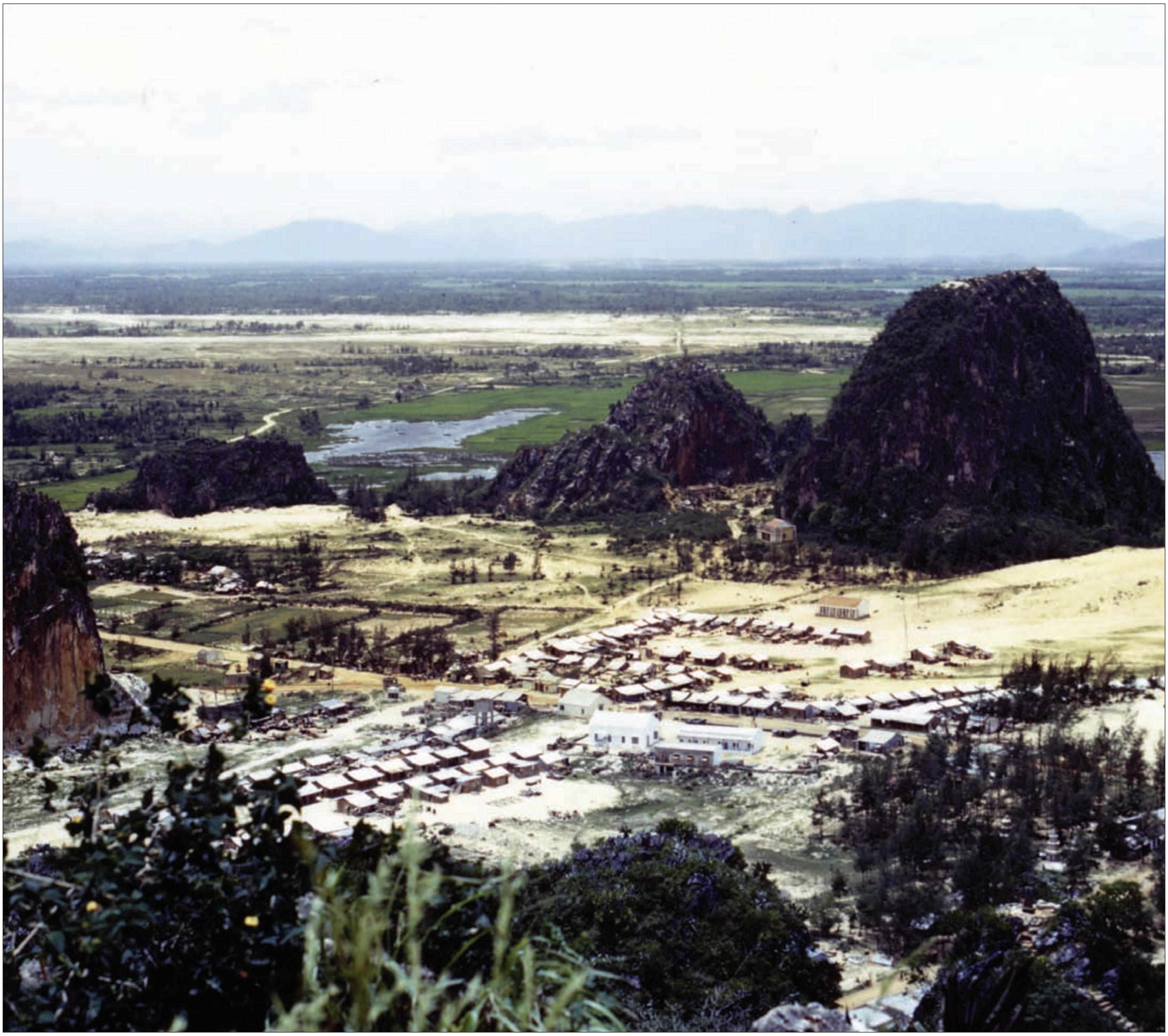
3rd Engineer Battalion deployed to Vietnam from June 1965 until October 1969, operating from Da Nang, Dong Ha, Gia Le, Quang Tri, Cua Viet, Camp Carroll, Cam Lo, and Vandegrift Combat Base. The battalion provided direct support to the 3rd Marine Division by building "pioneer roads," conducting route clearing, and performing minor construction. The battalion also was given the mission of developing a school to train infantrymen in demolition and mine warfare, soon nicknamed "The Punji Palace."

In less than a year from the opening of the school in September 1965, an estimated 5,000 Marines received instruction in the nature, operation, and avoidance of the enemy's numerous, ingenious booby traps.

(Top) Marine Corps engineers first arrived in Vietnam in early 1965 when C Company, 7th Engineer Battalion was sent to Da Nang (shown above in 1968) to support a Light Anti-Aircraft Defense Missile Battery. U.S. MARINE CORPS PHOTOS

(Left) Marine Corps engineers repair a bridge on Vietnamese Highway 9 on the road to Khe Sanh.

(Right) A bulldozer from C Company, 7th Engineer Battalion, widens the access road to the Hawk Missile Site on Hill 327 as a mechanical mule goes up the steep road on its way to the top in Da Nang, 1965.



Cpl. William Chaconas, USMC, with C Company, 3rd Engineers, removes a shoe box mine from a hole in the road in Vietnam, 1965.

FORCE TROOP ENGINEER BATTALIONS

The 7th Engineer Battalion deployed from August 1965 to August 1970. The battalion, based in Da Nang, augmented division engineers and found its companies often attached to 3rd Engineers to help clear roads and to Naval Mobile Construction Battalions to help build helicopter pads. One of 7th Engineers' unique achievements was constructing a 1,478-ft floating bridge across the Da Nang River in 1968.

The 9th Engineer Battalion served in Vietnam from May 1966 until August 1970. The battalion was located in and around Chu Lai, with Company A detached to support operations in the vicinity of Da Nang. While supporting combat operations in Vietnam, 9th Engineer Battalion was in direct support of the 1st Marine Division. The battalion's missions included the repair, maintenance, and reconstruction of highways; construction of bridges; demolitions, and mine and booby trap clearance; constructing and operating cable-linked ferries; and general engineering to construct and improve bases. The 9th Engineer Battalion returned to Camp Pendleton until being deactivated on Oct. 30, 1970.

The story of the 11th Engineer Battalion is unique to this period of Marine Corps engineer history. The battalion's colors were unfurled June 1, 1966. It was activated as part of the 5th Marine Division at Camp Pendleton as the Vietnam War buildup began. The battalion's advance party departed El Toro by government air and arrived in Da Nang on Nov. 8, 1966. The unit's equipment began to arrive by ships in late November and the off-loading of equipment was completed within one week. The battalion's command post was established at Dong Ha Combat Base on the first of December.

On April 11, 1967, 11th Engineer Battalion began operation on the Gio Linh to Con Thien "fire break," which consisted of removing all vegetation and clearing a strip 200-m wide on each side of the road and 10,560-m long. The engineers dug wells, operated water points, and built access and interior roads, bunkers, and ammunition supply points for the 3rd Marine Division. By the end of the battalion's first year of operations nearly 300

Marines received Purple Hearts. Individual bravery was no stranger to these men, as that first year brought the award of two Silver Stars, three Bronze Stars, and three Navy Commendation Medals as well.

Additionally, the 11th Engineer Battalion was committed to the important mission of opening Route 9 from Cau Lu to Khe Sanh in Operation Pegasus, which extracted Marines from Khe Sanh. The connecting link from Highway 9 to Con Thien, known as Route 561, was transformed from essentially a trail into a two-lane, all-weather highway as a result of their efforts. The battalion also constructed an asphalt plant, which had a production rate of 30 truckloads of asphalt a day for paving roads, helipads, and parking areas. The battalion continued in general support of the 3rd Marine Division, including in Operations Kentucky, Lancaster, Dawson River, Marshall Mountain, and Napoleon Saline I and II. When the 11th Engineer Battalion left in August 1970, 50 Marines had paid the ultimate sacrifice.

AIR WING ENGINEERS

There were various small elements within each Marine Aircraft Wing, which provided engineer support. A Marine Air Base Squadron (MABS) contained both a utilities unit and an engineer equipment unit in the motor transport section. The utilities platoon contained construction, electrical, laundry, plumbing, water supply and refrigerator sections. The engineer equipment unit consisted of equipment operators, mechanics, and electricians. It was capable of limited construction and maintenance support (roads, clearing, grading, bulk fuel, installation of drainage, and other engineer tasks). There were 17 MABS that served during Vietnam from 1965 through 1971 on air bases from Chu Lai to Da Nang and many more.

Marine Wing Support Group-17 deployed from Marine Corps Air Station Iwakuni, Japan, to the Republic of Vietnam in September 1966. The squadron actively participated in the war from September 1966 until August 1970, operating from Da Nang and earning a Presidential Unit Citation and a Meritorious Unit Citation. In the summer of 1970, Marine Wing Support Squadron-17 returned to Iwakuni.

INNOVATIONS SINCE VIETNAM

In the decades since the Vietnam War, engineering in the Marine Corps has evolved greatly, in training, equipping, logistics, and organization.

Training. All Marine Corps engineers are trained as infantrymen first and engineers second. This enables the Marine to focus all his energy on supporting the warfighting mission. It is interesting to note that during World War II, the German engineers also were trained as infantry first.

The Marines did not forget their lessons from the past. With the lessons learned from Vietnam on booby traps and mines, the following decades demonstrated that improved training for combat engineers in how to make, plot, and breach mine fields; construct field defenses; emplace demolitions, and conduct engineer reconnaissance. Additionally, the Marine Corps found that its engineers (officer and enlisted) needed more training from formal schools, distance education, and on-the-job training from senior Marines. For example, the Officer Engineer Basic Course increased from eight weeks in 1974 to its current 13 weeks of comprehensive combat engineer training.

Equipping. Marine Corps engineers in Vietnam essentially used tools and equipment that had been unchanged since World War II. Even some of the engineer leader terms were a throwback to earlier years: the use of "Construction Foreman" instead of sergeant, gunny, or platoon leader. The equipment used by the engineers was civilian in nature and vulnerable in combat situations. The older bulldozers were slow and cumbersome and the noisiest piece on the construction site. Much of the engineer equipment had to be modified for protection from hazards. Today's equipment has been battlefield protected with communications, armor, and enhancements, such as laser levelers. Marine Corps engineers relied heavily on U.S. Army equipment and doctrine in the past, and still do to some extent. But the Marine Corps Combat Development Command now is essential in the development and improvement of the engineer capability, working hand-in-glove with Marine Corps Systems Command to ensure equipment is on the cutting edge of technology and poised to support the missions of today and tomorrow.

A great example of a long sought-after mobility asset is the rapid development and combat employment in December 2009 of the Assault Breacher Vehicle (ABV), which introduced a new method for combating improvised explosive devices. Built on the chassis of a M1A1 Abrams Tank, the tracked ABV is equipped with a mine-clearing plow, a .50-cal machine gun, and a device that fires a rocket-propelled line of C4 explosives up to 150-yd.

Utilities. New water purification systems are now in use along with new water distillation equipment. Shower units utilizing hot water are now being used instead of the 55-gal containers and 500-gal fuel and water tanks. New laundry equipment has been purchased and better tracking of garments has been installed. Simpler electrical power distribution equipment also has been put into use.

Bulk Fuel. One of the newest components to the Bulk Fuel components is the Petroleum Quality Assurance System—Model E (PQAS-E). A mobile petroleum laboratory that is used to check the quality of different fuels in a combat zone, PQAS-E is fully self-contained with different testing and quality assurance equipment. It can be closed up into a cube shape and ready for transport.

On April 11, 1967, 11th Engineer Battalion began operation on the Gio Linh to Con Thien "fire break," which consisted of removing all vegetation and clearing a strip 200-m wide on each side of the road and 10,560-m long.

There are two main types of fuel dispensing systems: the Tactical Fuel Dispensing System (TFDS) and the Amphibious Assault Fuel System (AAFS). The mission of AAFS is to receive, store, transfer and dispense fuel to all elements of a Marine Air Ground Task Force, including distribution to forward operating bases. Versatility is an important part of AAFS. It can receive fuel from offshore vessels, railcars, tank trucks, or virtually any source. AAFS has a maximum storage capacity of 1.12-million-gal.

TAFDS can receive fuel directly from AAFS or other ground sources at a rate of 600-gal/min. TAFDS can simultaneously refuel up to 12 aircraft at a time. The total capacity for a unit is 320,000-gal of fuel.

Meanwhile, the mission of the Hose Reel System (HRS) for the Tactical Fuel System is to provide storage, transport, powered or manual deployment and powered retrieval of lightweight 6-in hose. There are 11 reels to a system. The hose can be deployed at an average of 2-mph and retrieved at 0.5-mph. HRS can operate on a 20° slope and is able to dispense fuel up to 5-mi.

The Marine Corps continues to focus on its proficiency in getting fuel ashore, and then pushed deeper into the area of operations to support rapid and distributed operations. There are exercises in California and Korea where much of training relies on the ability of fuel to move from ship to shore.

HONOR, COURAGE, AND COMMITMENT

One of the legacies created in Vietnam that Marine Corps engineers proudly note is they are the only Marine Corps occupational field with "combat" in their job title. The Division Engineer Battalions are now known as Combat Engineer Battalions, while the old Force Troop Engineers are now Engineer Support Battalions.

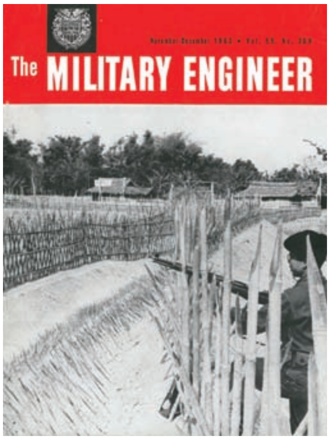
Many believe Marine Corps engineers started as combat units. In reality, engineers were service organizations. Vietnam stripped away much of the original mission of seizing naval bases and fixing or building wharfs, buildings and essential infrastructure, water purification systems, sewage, laundry, ice and administration. It forever placed the roles of mobility, counter mobility, and survivability in the forefront.

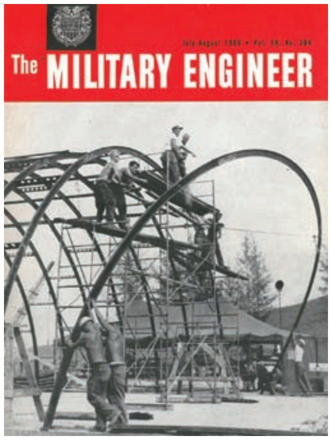
As the Marine Corps goes boldly into ensuring it is the force of choice and ready when all others are not, Marine Corps combat engineers will be there alongside the infantry, running to the sound of the guns, just as they did in Vietnam. Engineers up!

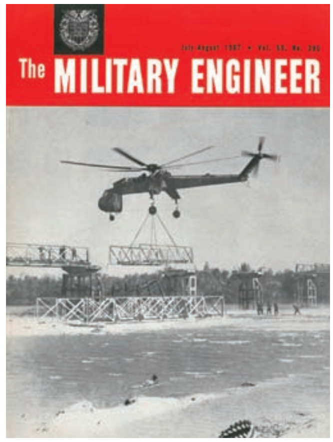
TME

Col. Robin Gentry, USMC (Ret.), is Historian with the Marine Corps Engineer Association, and Master Sgt. Phil Martin, USMC (Ret.), is Assistant Historian. They can be reached at texmarine@aol.com; and bulkfuel@comcast.net.

See page 126 for article sources and suggested further reading.





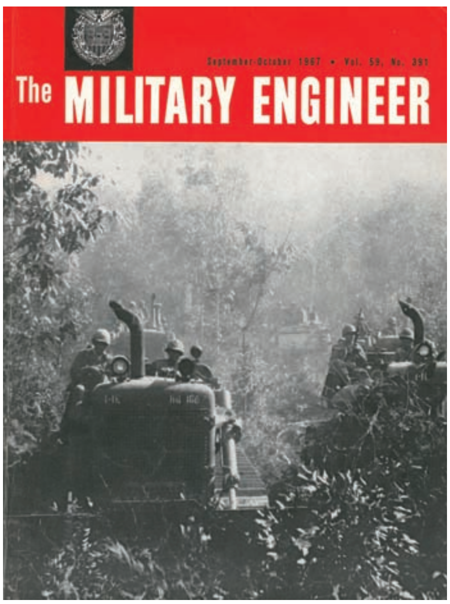


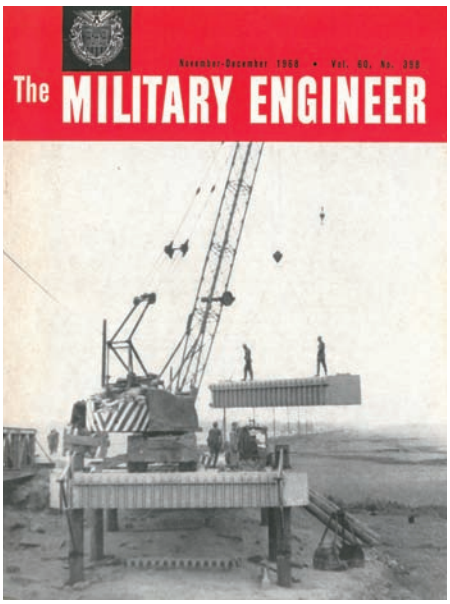
BRINGING HISTORY FORWARD

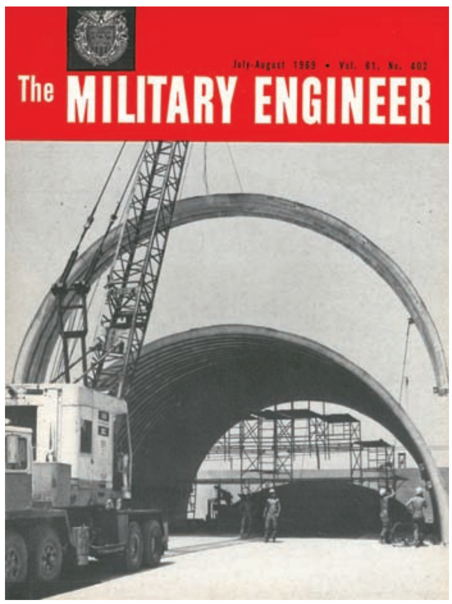
Since its inception in 1909 as Professional Memoirs, and since 1920 under its current masthead, The Military Engineer has been the leading voice chronicling the contributions and achievements, and the legacy, of military engineers and those aligned with ensuring the national security of the United States.

From the onset of United States involvement in Vietnam to the drawdown of troops and the Vietnamization program, an enormous amount of articles, news items, photographs, reports and editorials appeared in the pages of *The Military Engineer*.

The text within the articles that follow is reprinted as originally published from 1963-1972. The articles were selected to provide an understanding of the wide array of roles that engineers took on, and to include perspective from each of the military services and from industry. While these articles may be just a fraction of the Vietnam-era material residing in the *TME* archives, we hope they help bring history forward, and give renewed appreciation to the incredible service, and sacrifice, of engineers in Vietnam.







Elephant Power in Southeast Asia

ELEPHANTS and People Power

By Lt. Cdr. Malcolm T. Mooney, Civil Engineer Corps, United States Navy

In the Military Assistance Program which has been under way in Southeast Asia since 1956[1] over half of the construction work has been by local contractors, and unique construction methods have been encountered. In this area men and women toil ten hours a day seven days a week, using primitive and ingenious practices which are natural in an unmechanized society where labor is cheap and plentiful. Considering the resources available and the technological limitations, the results obtained are remarkable.

CONDITIONS

About half of the Southeast Asian peninsula consists of rice paddies and the rest comprises high plateaus and mountainous regions. Vegetation ranges from nothing to scrub brush to dense jungle. The construction season is generally from October through April or May with the summer months bringing the monsoon season with its accompanying heavy rains. In the northern part of South Vietnam, the seasons are nearly reversed with rains occurring from October through March. During the rainy seasons the lowlands are flooded and the earth turns to ooze several feet deep and completely unworkable for heavy construction equipment. In the construction season, this same materials, so high in clay content, hardens and bakes in the tropical sun to a solid base covered with several inches of fine dust.

Construction materials that are readily available are lumber, cement, clay, river and beach sand, river-run gravel, crushed rock, and laterite. Common brick, masonry tiles, and concrete blocks are used with reinforced concrete as the standard elements for basic construction. Steel and other metal materials and petroleum products must be imported from other Far Eastern sources or the United States; hence, design standards have been developed to make maximum use of the local materials.

EARTHWORK

Clearing and Grubbing.—Clearing the ground in preparation for construction provides a splendid opportunity for work for the multitude of unskilled coolies available. They are quite willing to put their backs into the heavy work for a small daily wage. Apparently living by the adage that "haste makes waste" they are in no hurry but are slow and very steady. If speed is required, the rate of progress is increased by the addition of workers.

In clearing operations the elephant is particularly valuable. Under the skillful guidance of his owner, trainer, provider, driver, and maintenance mechanic (all the same person) the elephant is useful in tree and boulder removal and in hauling heavy loads. Here is a vegetarian bulldozer that refuels off the local greenery, washes itself, and requires no spare parts support. But, unique as construction equipment, the elephant is emotional and sensitive. The elephant handler must therefore serve also as a psychiatrist for his charge. One report tells of a particular elephant that had been born with a defective trunk. This handicap made him self-conscious over the years because he was suitable only for hauling jobs and was not used on the choice lifting work being done by his fellows. His neurosis on this account finally overwhelmed him to such a degree that he ran headlong into a stone wall at full speed, thus removing himself from an intolerable life. So, while the risk of mechanical breakdown is slight, the possibility of a nervous collapse has replaced it.

Excavation and Grading.—Digging holes is still practiced in this area in its most ancient form. With a short-handled type of hoe a good digger can dislodge and load sufficient material to keep three or four coolies busy hauling it in small woven bamboo baskets on the ends of their carrying poles. Of course, the number of coolies per digger will depend upon the depth of the excavation and the haul distance. If the hole is deep, it is often necessary to employ a middle man (or woman) to hand up the filled baskets and lower the empty ones.

A variation on this method has been found at the site of a ground-water well installation. There, water was located about 12 feet below the surface under a sand overburden. To preclude digging a hole two to three times larger than the final necessary size in order to place forms for concrete, a reinforced concrete ring about 10 feet in diameter, 4 feet high, and with 6-inch wall thickness was cast on the well site. After stripping it of the forms, some half dozen coolies jumped inside the ring and began excavating the sand by hand. As the soil was removed from inside the ring and from under its rim, its weight caused it to settle into the ground. When the top of this ring reached ground level, a second one was cast on top of it, and work continued as before. A small hand winch with a bucket was added as the excavation deepened, to remove the material which was then hauled off by coolies with shoulder poles and baskets. When sufficient depth was reached, the piping was put in, a top was cast, and pumps were installed.

Some type of equipment is usually involved in grading and compacting operations. It may be only an old dump truck or two being loaded by hand. Compaction requires something more than hundreds of bare feet, so an ancient steam roller is used. A convenient supply of boiler firewood is found at the carpenter shop where scraps are gathered and loaded into the steam roller cab. The equipment operator doubles as fireman during operations.

Placement of fill is also largely a coolie operation supported by horse and truck hauling. Pavement base courses often consist of a first layer of relatively large, hand-broken rock which is also placed by hand. This is then chinked with smaller crushed stone (hand spread and broomed), rolled, and shot with asphalt in typical macadam fashion.

Drainage structures are generally either open surface ditches or precast concrete pipe. Some of the headwalls and open spillways become beautiful examples of masonry construction. Because of heavy runoffs during the monsoon seasons, erosion prevention necessitates masonry or hand-sodded ditch linings.

Drainage structures are generally either open surface ditches or precast concrete pipe. Some of the headwalls and open spillways become beautiful examples of masonry construction.

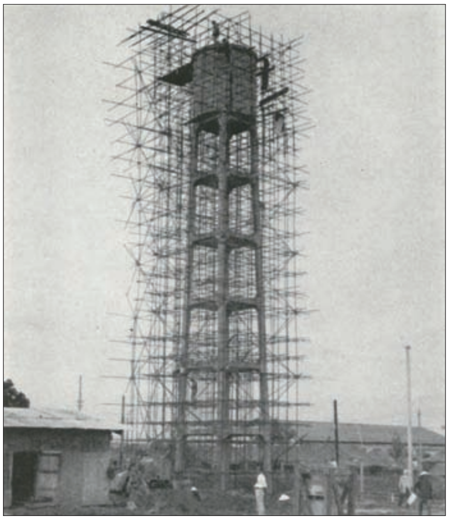
CONSTRUCTION

Pile Driving.—This is one of the most fascinating construction procedures. On small jobs the piles are usually of teak or other local hardwood. The technique and equipment used for driving will depend upon the nature of the soil and the degree of inventiveness of the contractor.

One system involves a large woodblock with handles on either side which is lifted and dropped by two men standing atop a staging. The fall of the weight is probably not more than 12 to 18 inches but it does the job in rice paddy areas underlain with saturated soil. The pile leads consist of one or two men at a lower level holding the pile erect until it is sufficiently embedded to remain upright.

A slightly more advanced method involves a concrete block as the hammer and several coolies as the motive force on the end of a line that runs over a pulley. Pile leads may be the same as in the woodblock method.

Another method employs a concrete weight that is operated by an engine-driven winch instead of manpower. An A-frame, which is usually skid mounted, supports the pulley arrangement and leads. Rebar dowels, several feet long, extending out of the



(Far Left) Ancient Excavation Method
(Left Center) Preparation of Fill and Paving Materials
(Right Center) Placing Concrete from Baskets
(Far Right) Typical Bamboo Scaffolding

hammer and its four corners enclose the pile when driving and ensure hitting the target. Reinforced concrete piles are driven by this method.

To the more specialized contractors in this field, there are available in limited quantity the usually assortment of steam hammers and conventional pile-driving rigs which are used for the large jobs requiring extensive piling.

Concrete Placement.—Concrete is mixed in moderate-sized, portable, engine-driven mixers at the site. When more volume is required, more units are used. The aggregate and cement are measured out in boxes by coolies and loaded into the drum. Water is added by pail or dipper for control. When mixing is complete, the load is dumped on a prepared surface near the unit and then shoveled into buckets or baskets for transportation to the job. Various systems are used for placing the mix, depending upon the height of the forms or pour level. They range from ramps for the coolies to ascend to bucket-brigade operations. One contractor who was placing concrete at a third-floor level had a power unit attached to pulleys over which ran a steel wire rope with hooks on it about every 3 feet. The worker on the ground floor attached buckets of concrete by letting the hooks catch the handles; when they reached the third floor they were grabbed and removed by another worker. He passed them to a coolie who delivered them to the site, returning with empty pails which were lowered on the hooks on the opposite side of the wire rope circuit.

At one concrete job an inspector noted the apparently weak formwork at the base of a column. The contractor assured him that there was no danger since the pour was so slow that the concrete would set up before any reaction from hydrostatic head would be a problem. All vibration is by hand rodding of the mix after placement. Finishing is by hand.

Other Phases.—Masonry, carpentry, and electrical, plumbing, and mechanical work are as might be expected. The tendency is toward minimum mechanical methods and maximum manual work. In Cambodia, where no general contractors are available, it is necessary to let separate contracts for each particular phase of a project. This requires patience and timing in order, for example, to see that the structure is in place before the plumbing and electrical contractors go to work, or that the floor is not finished before a drain or other fixtures are installed under it. In view of this situation, conduits and pipe will often be surface mounted. The aesthetic values of interiors and exteriors are somewhat reduced by such practices but maintenance is simplified.

Safety.—The standards of safety customary in the United States are not observed by the local Southeast Asian contractors. A conscientious safety engineer would be completely frustrated if given the task of enforcing American standards in this area. Scaffolds are usually of bamboo lashed together with local materials. These structures will extend upward to any required height and the natives scramble up and down without ladders, stairs, or other contrivances. That there are not more accidents in all phases of the work may be partially attributed to the dearth of mechanical equipment.

CONCLUSION

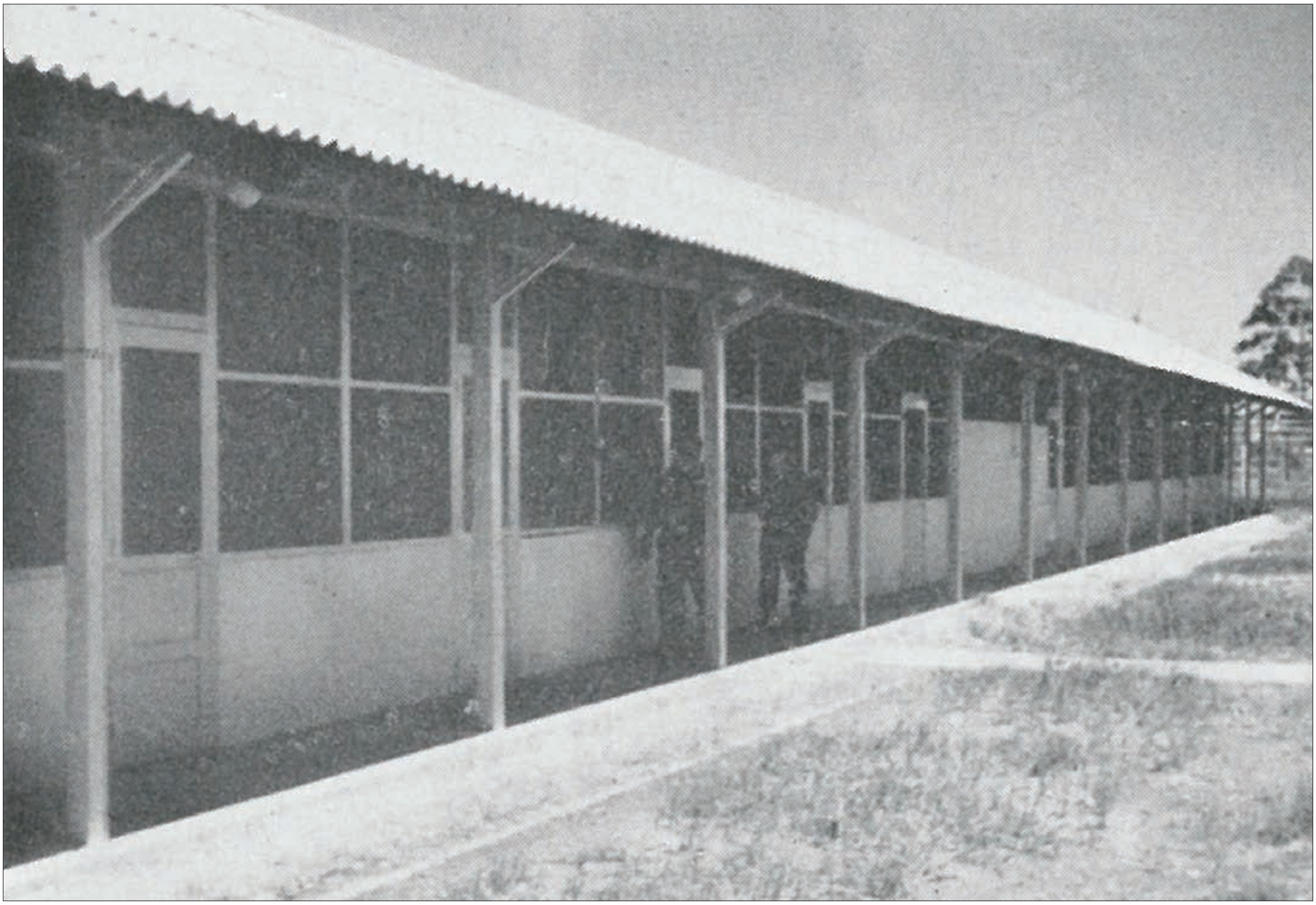
A few American and foreign contractors have moved into Southeast Asia bringing with them modern equipment and methods. These firms employ large numbers of local personnel who are being trained to handle various kinds of mechanical construction equipment.

While construction practices in this region may improve in efficiency and modernization, the progress will be slow and gradual because of the large pool of hand labor available. In such conditions, it cannot be said that replacing a hundred coolies with one bulldozer is necessarily a good thing. On some projects a local contractor with a large labor force has been known to surpass the foreigner in flexibility, responsiveness, and speed of construction, and with far less trouble over the cost and effect of a change order on his job.

TME

[1] Under Director, Pacific Division, Bureau of Yards and Docks, and the Officer in Charge of Construction, Bureau of Yards and Docks Contracts, Southeast Asia in Bangkok as Construction Agent.

First published in The Military Engineer, January-February 1963.



Permanent, 12-man Billet

CONTRACTING
in Vietnam

By Capt. Loring B. Bean, Corps of Engineers, United States Army

In the fall of 1961, the United States Military Assistance Advisory Group (MAAG) in Vietnam began a major expansion to help meet the rising communist threat in that country. Until then, relatively few Americans were stationed outside of Saigon, and they were usually grouped in detachments of twenty men or less, quartered in renovated buildings.

Soon after the increase in personnel started, it became evident that many more and larger field detachments would be established in new areas and small villages where suitable housing for them did not exist. They would require mess halls, communications, emergency power, and other supporting facilities.

To complicate the problem was the fact that the men to be billeted were mostly officers and senior noncommissioned officers, and the standard enlisted mobilization-type barracks would not be adequate for a year of confined living. Available utilities were generally poor or nonexistent; electric power was seldom available; and the water supply was not potable (even in the capital city of Saigon). Since the detachments were to be stationed throughout the country, an area of about 100 miles wide by 500 miles long was involved. The exact location and size of the detachments depended upon the disposition of the Vietnamese Army units, which in turn depended upon the localities in which the communists (Viet Cong) were active. The location of the detachments changed as the areas of enemy action shifted, sometimes even before construction could be started.

Because of the low cost of local construction and the availability of materials and labor, it was decided that local construction would be used rather than prefabricated buildings. Since there were no American construction units on hand, the work was to be done by Vietnamese contractors. They proved to be quite capable, even though they had little equipment and few skilled workers. They found the difference in languages a serious handicap, but they were eager to do a good job.

CONSTRUCTION STANDARDS

Standard building plans for local construction were developed along two lines: one a temporary low-cost facility, the other a more permanent type of structure. The basic temporary unit was a 5-by-18-meter one-room dormitory building with a concrete floor, wood and screen siding, and corrugated asbestos roofing. It was suitable for six to eight men. A similar building was provided for a mess hall, kitchen, and lounge. The latrine was in a separate masonry building.

The more permanent unit was a line of billets built somewhat like a motel, with a covered walkway in the front and a latrine in the center. The builds were in ten-, twelve-, or sixteen-room units. The rooms were 3.5 by 4 meters, adequate for one man, but large enough for two if necessary. The building has a concrete floor and masonry sides 1 meter high with screens and shutters above. A masonite ceiling reduces the temperature and keeps insects out. Each room is usually provided with a ceiling fan. The roof is of corrugated asbestos on wooden trusses. A building of similar design, 7 meters wide, houses a kitchen and mess hall. A similar building for recreational activities may be provided if the size of the detachment warrants it.

Standard designs were developed for generator sheds, laundry buildings, water towers, security fences, and other necessary structures.

Except in the large cities, commercial electrical power is usually inadequate, and what little there is is furnished only during certain hours. Since electric power is required on a 24-hour basis for communications, security lights, and food refrigeration, the policy is to make maximum use of commercial power where it is available and supplement it with diesel electric generators. In places where it is not available two generators, each capable of carrying the entire cantonment load, are supplied.

CONTRACTING

At the start, the entire support operation was handled by MAAG, Vietnam. Construction contracts were handled by a purchasing and contracting section using plans and specifications prepared by the engineer section. In July 1962, Headquarters Support Activity, Saigon, was established by the Navy to provide support to MAAG. Construction contracts were administered by the public works officer of the Activity. Later the work was divided, giving the Officer in Charge of Contracts (OICC), Southeast Asia (Navy), responsibility for contracts valued over $10,000.

Construction contracts are handled under competitive negotiations. This allows the contracting officer to invite contractors to submit sealed proposals on a project. He then negotiates with the contractor submitting the lowest proposal. This is a necessary procedure because performance bonds are not obtainable, and the work must be properly completed on schedule.

The proper submission of the required forms and schedules by the contractors has proved to be a serious problem. The schedule of prices, for example, which requires simply a detailed listing of each item of work by quantity, unit material cost, and unit labor cost, is extremely difficult to obtain. It would seem that these items would have been worked out by the contractor in order to make his proposal, but apparently not!

INSPECTION

Contract inspection is a critical factor in the program. The Engineer Section is small and transportation is at a premium. The jobs have been numerous and widespread. Even if aircraft were assigned for the purpose, it is estimated that each construction site could be visited only once every three weeks.

The solution has been to detail a member of local detachment an additional duty as a contracting officer's representative. Results of this practice have varied, since the quality of the construction obtained thus depends upon the qualifications of the representative appointed, whether he is, in fact, living at the construction site, and the amount of time he can devote to inspection in addition to his regular duties. A resident inspector assigned to each construction project could improve the whole construction effort. An experienced NCO, acting as a resident inspector in addition to his regular duties, would be able to give excellent on-the-job instruction to the foreman and his men. This could be an exceptional opportunity to teach basic construction methods, by example, throughout the country.

Some instruction efforts were made early in the expansion program when Vietnamese translations of specifications and drawings were provided. In addition to this, a prebid conference was held which all bidders were required to attend. At this conference, usually held at the construction site, the entire job, plans, and specifications were discussed with the aid of an interpreter.

As time became a critical factor, the written Vietnamese translations were discontinued and only the prebid conference was retained. Although the use of an unofficial translation may be risky insofar as legal contract administration is concerned, the additional understanding which it gives to the contractor and his foremen is considered worth the risk.

CONCLUSIONS

Where difficulties were experienced in the program it was often something of which it could be said: "Well, they should have known better." With the benefit of hindsight, some suggestions for the success of future programs of this type may be offered.

First, standards for construction must be established. Just what sort of facilities are to be provided, and at what cost? What are the utility requirements? How about security? Such questions must be answered before the program can begin.

Second, the objectives of the program must be clearly defined. Is it to get the most construction at the least cost? Is it to get the work done as soon as possible? Is there some other important consideration—as, for example, in a country like Vietnam where one of the principal weapons for fighting communism is a better standard of living? Certainly a housing program, dispersed throughout the country, provides an excellent opportunity for training local skilled labor, and presents a visual lesson in good layout, design, construction economy, and sanitation.

Finally, where local contractors are to be used, the contracting officer must be given the means to accomplish the job: authority to modify bidding procedures to suit the needs, an adequate staff, and competent inspectors.

In the program for MAAG in Vietnam, the required policy decisions were made, and the facilities provided are filling the basic needs of the detachments. The use of local construction contractors, even with their lack of skilled workers and equipment, has proved successful. And despite the urgency of the program and the security requirements, the cost has remained low.

TME

First published in The Military Engineer, January-February 1964.

Military Geography of Indochina

By James A. Reynolds

In view of the present situation throughout Indochina and the increased United States involvement there, it is important that the American military engineer visualize and understand the conditions that exist in that region.

GEOGRAPHY

Indochina is a geographical term which designates the area of the former colonial territories of French Indochina. It consists of four independent countries: North Vietnam (the Democratic Republic of Vietnam),[1] South Vietnam (the Republic of Vietnam), Cambodia, and Laos. Together, these countries occupy about 283,000 square miles, an area about the size of the State of Texas. The population of 39,000,000 comprises—17,000,000 North Vietnamese, 15,000,000 South Vietnamese, 5,000,000 Cambodians, and 2,000,000 Laotians. The population is most heavily concentrated in two regions: the Tonkin delta in the northeast, which contains the cities of Hanoi and Haiphong, and the Mekong delta in the south, which contains Saigon. These are the two most important rice producing areas in Indochina.

CLIMATE

The climate is controlled by the prevailing winds and the configuration of the terrain. During summer, May through September, warm moisture-laden winds blow into Asia from the southwest—the southwest monsoon. This brings rain to the slopes facing westward and southwestward. Conversely, in winter, October through March, the monsoon wind is from the northeast, bringing rain to all eastward exposures. Thus, in a country where temperatures are always warm, with mean daily temperatures ranging from 70 to 95 degrees Fahrenheit, the variation in climate is in the timing and amount of rainfall. Local variations in rainfall are great, but usually there are 50 to 115 inches annually. From January through April, the northeast coast is subject to periods of low, dense clouds, fog, and drizzle, known as *crachin*, which may persist for as long as two to three weeks with few breaks during which the sky is visible. These severely restrict air operations. The eastern coast may be subjected to one or two typhoons each year.

TOPOGRAPHY

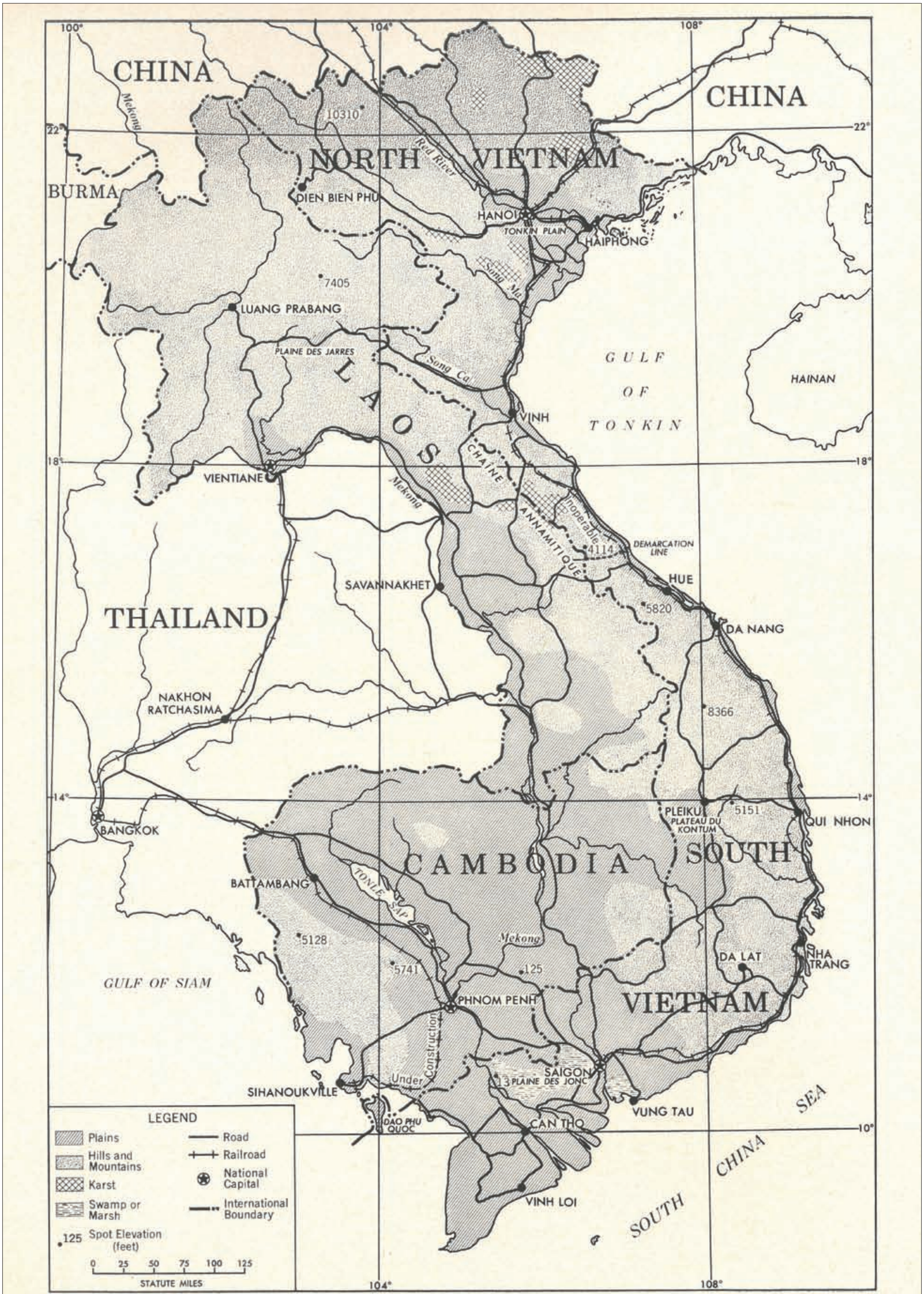
Throughout most of its length, Indochina is divided by the Chaîne Annamitique, which forms a major barrier between the coastal plains of Vietnam and the interior plains of Laos and Cambodia. The Chaîne consists of rugged, densely forested mountain and hill ranges, in a northwest-southeast direction

(Top) Karst Area in Mountains of North Vietnam (Bottom) Rice Field in Mekong Lowland

with spurs at right angles to the main ridge which break up the valleys between. In northwestern Laos, mountains trend northeast-southwest. Summit elevations are generally between 5,000 and 8,000 feet above sea level, and ridges stand more than 3,000 feet above valley floors. The highest peak, slightly over 10,000 feet, is in northwestern North Vietnam. Extensive areas of karst, extremely dissected limestone ridges and pinnacles, are common throughout the mountains and bordering hills. Through the highlands, streams flow swiftly in deep, narrow channels.

Bordering the hill and mountain areas are the plains: the Tonkin delta in the northeast and the Mekong delta in the south, and along the coast between these two are the coastal plains which are interrupted in places by spurs of the Chaîne Annamitique. The plains are low, flat, poorly drained, and intensively planted in wet-land rice. Meandering streams and networks of irrigation and drainage canals lace these areas.

West of the highlands of the Chaîne Annamitique are numerous higher plains or plateaus, such as the Plaine des Jarres in Laos and the Plateau du Kontum in South Vietnam. These elevated plains consist mostly of grass- and scrub-covered rolling terrain with some open forests. Rice and dry crops are cultivated along many of the drainage ways.



Geographical Map of Indochina, 1965

To the southwest lies Cambodia, primarily a low flat plain that rarely exceeds 50 feet elevation. A feature which greatly influences life in Cambodia is the Tonle Sap, a shallow lake which overflows during the flood season. From January to June, the lake drains into the Mekong and is normally 100 miles long by 20 miles wide at its widest point and 6 feet deep. Floods in July through September, resulting from the southwest monsoon, reverse the flow from the lake, tripling its size and increasing its depth to 40 feet or more. This alternate filling and draining of the Tonle Sap, with its consequent variations in water surface elevation and extent, greatly affect construction, rice cultivation, and movement around its shores. In southwest Cambodia, a narrow band of partly forested, rugged mountains with broad, rolling summits and steep, severely dissected slopes rise to a height of 5,000 feet.

Steel Bridge in South Vietnam.

TRANSPORTATION

The ruggedness of the area has restricted its development, limiting overland transportation mainly to the two main river basins and a narrow strip along the east coast. Primary roads, mostly one or two lanes wide, have bituminous-treated or crushed-stone surfaces, and are constructed on an embankment to prevent flooding. Secondary, one-lane roads have earth or gravel surfaces and are subject to frequent flooding or washouts. Bridges on main roads are usually of steel or reinforced concrete; those on secondary roads are mostly timber or light steel. Many of the bridges are narrow and of low capacities, and numerous fords and small ferries exist, some even on main routes.

The rail lines of Indochina, all meter gage, are separated into three national networks—North Vietnam, South Vietnam, and Cambodia. There are no rail lines in Laos. The two Vietnamese systems were joined prior to the war with France, providing service from Saigon to Hanoi, but most of the lines in North Vietnam were destroyed during that war and have never been completely rebuilt. The main line was reopened in mid-1964 as far south as Vinh. Now the rail lines of both North Vietnam and South Vietnam are frequently blocked and destroyed. In South Vietnam, the Communist Viet Cong mine the track and destroy bridges. In North Vietnam, American and South Vietnamese aircraft bomb and destroy railroad bridges. It would be impossible to predict how much or what portion of either rail system will be in operation at a given time. Rail traffic moves across the Communist Chinese border northwest of Hanoi where the Chinese and North Vietnamese rail lines are both meter gage; but at the border northeast of Hanoi, the lines are of differing gage and transloading is necessary.

Navigable inland waterways are important supplements to overland transportation, the Mekong, the Tonle Sap, and the Red River being the principal systems. The mouths of the Mekong, with their interconnecting canals and tributary streams constitute a network of trade routes over which native junks have traveled for centuries. The only two significant ports in these systems, Saigon and Haiphong, are both upstream from the coast line, Saigon being 46 miles inland and Haiphong 16 miles inland. Port facilities at both are adequate for POL storage, warehousing, and docks and berths for local and regional needs.

The relative insecurity of surface travel has added increased importance to the expansion of air travel. Airfields and landing strips of varying sizes have been constructed throughout Indochina. A few are suitable for heavy jet transports. Although most airfields are primarily for military use, civilian air traffic has shown a marked increase over the past few years.

MILITARY OPERATIONS

From the standpoint of military operations and logistics, the maneuver and supply of large forces would be severely hampered by the rugged forested mountains, the numerous streams, the extensive rice fields, and lack of an adequate transportation system. Conversely, the terrain is ideally suited for the guerrilla warfare, such as that being conducted by the Communist forces in South Vietnam and Laos. Insurgent forces emerge from hiding to destroy bridges, crater roads, assault a lightly defended outpost, or spring an ambush. Then, before the conventional government forces can react, the insurgents return to the relative security of the dense forests, swamps, or rice fields.

With the introduction of American ground combat units into South Vietnam, the military engineer is being called upon to counter the combined adverse effects of terrain, climate, and guerrilla activity. He must construct and maintain suitable roads and airfields for logistical support in densely forested mountains and flooded fields. He must insure rapid movement of tactical units across terrain where movement is virtually impossible. He must prepare defensive barriers on terrain that greatly favors the attacking guerrilla forces. The ability of the military engineers to perform these operations will be a major factor in the attaining of peace in Indochina.

TME

[1] The Democratic Republic of Vietnam has developed from the so called "Viet Minh" communist regime of Ho Chi Minh, sponsored by the U.S.S.R. The rise of the Viet Minh resulted from nationalist opposition to the French colonial authorities who had submitted to Japanese pressure and Vichy authorization to continue administration of the country after the fall of France in 1940. Ho Chi Minh organized the nationalist guerrilla forces to fight the Japanese and the identification of the French colonial authorities with the Japanese military invaders during the period 1940-1945 provided double objectives of hatred for the nascent nationalistic movement. There is a long story behind the political, economic, and social situations associated with the present conflict in Vietnam.

First published in The Military Engineer, September-October 1965.

Operations at Cam Ranh Bay

By Capt. Lindbergh Jones, Corps of Engineers, United States Army

(Left) Engineer Base Camp (Right) Quarry at Cam Ranh Bay

The construction of a major logistics base and port facility on the Cam Ranh Peninsula in Vietnam, under conditions of warfare, has posed many difficult engineering problems. This base is urgently needed to support the American military operations there and, additionally, as an economic benefit to the civilian communities adjacent to the peninsula.

The 35th Engineer Group (Construction),[1] assigned the construction of this project, landed in a barren, unpopulated area on Cam Ranh Bay on June 9, 1965.

The peninsula is 28 kilometers long and 8 kilometers across at its widest point. The terrain consists of large sand dunes, barren in the southwest, and covered with low shrubs in the north. The southeastern tip is dominated by mountainous masses of granite and sand dunes thickly covered with forests.

As the troops began to unload on the day of their arrival, it started to rain heavily and kept up until the early hours of the following morning. However, this was unusual for it was the dry season, and very little precipitation could be expected in the months ahead.

The engineer units found themselves ashore in a hostile land without infantry lines securing the front. A small screening force of Vietnamese troops had been provided for security in the early critical stages of establishing the bivouac. The first night, temporary machine-gun positions were established and listening posts were placed well in front of the lines and on high ground. It was an apprehensive first night, with many inexperienced young soldiers in this strange environment. The presence of seasoned NCO's, some of them veterans of previous wars, strengthened the morale of the troops. One unit received several rounds of long-range sniper fire, but having been trained in the engineers' traditional secondary mission, "to be able to reorganize and fight as infantry," the soldiers took appropriate action without wild random firing of weapons or other signs of excitement.

The immediate problems that faced the engineers were deep sand (which immobilized much of the heavy equipment); a lack of natural materials (such as river run gravel for use in the stabilization of roads and hardstands); and security (to make the area safe for continuous engineer construction operations).

SAND AND STONE

The problems resulting from the sand seemed insurmountable at first. The sand has a high silicon content and the grains are round with very little gradation and are extremely difficult to stabilize. In digging open water wells, it was found that the sand was 15 to 20 feet deep over the rock formations with no plastic clays in evidence. This sand provides unlimited material for filling sandbags, which are used to build everything conceivable, such as bunkers, machine-gun emplacements, walls, barriers, sidewalks, and even stairs. But otherwise it is a nuisance, and an expensive nuisance. Heavy rubber-tired equipment such as 5-ton trucks and truck-mounted cranes were nearly immobilized. In order to move equipment from the ships to the work areas, trails had to be cut through the enormous dunes by bulldozers.

The dozers were then left along the road in critical areas to tow stalled vehicles through the sand.

Thus the sand has been a constant, implacable enemy from the first day. The troops found the sand difficult to walk in, and the calves of their legs ached after trudging through it for any distance.

Fortunately, the mountain tops jutting out of the dunes provide ample rock and some laterite for binding the sand and providing a surface. Laterite is a decomposed rock, containing iron oxide, that is plentiful in Southeast Asia. A quarry was opened about a mile and a half from the engineer camp.

As soon as crushing equipment could be unloaded and set up, Company A of the 864th Engineer Battalion[2] started quarrying and crushing operations. Quarry teams are taking out granite, which is crushed by four 75-tons-per-hour plants working around the clock. Larger units are in transit to increase the production rate. The crushed rock was added to the existing roads as an interim solution to provide some stabilization in the shortest possible time. The roads are generally built with a 3- to 4-inch course of crushed rock and a 2- to 3-inch surfacing of laterite.

Better trails speeded the movement of equipment, supplies, and personnel, and released the tractors from stand-by duty to high-priority construction work. Even the tailings (waste product) of the quarry, which contained some laterite, were used for road stabilization. As asphaltic materials become available, the 102d Engineer Company (Construction Support)[3] will bring the roads to final grade and pave them.

The sand not only stalled traffic but in addition to the corrosive climate bred of heat, salt air and humidity, it also caused serious maintenance problems through its abrasive action on moving parts of the equipment. The pusher-type fan on some of the tractors drew the flying sand from the tracks into the engine compartment and pushed it through the radiator at a very high velocity. This had the effect of a sand blaster, severely damaging the fins and tubes of the radiators. Track rollers, track drive sprockets, pins, bushings, and sheaves all wore much faster than is normal. Field expedients kept the equipment rolling. Side covers of canvas or sheet metal were used to close the engine compartments to help keep out the sand. Drive sprockets were built up by welding, and the unit machine shops fabricated pins and bushings. One use of the sand is for making a low-grade concrete, which is adequate for floor slabs and hardstands. Near the quarry a central batch plant has been set up, using four 16-cubic-foot mixers in battery. Concrete is hauled from them in 5-ton dump trucks to the job sites. Approximately 300,000 square yards of concrete floor slabs have been placed, and metal prefabricated and wooden-frame buildings are being erected on the slabs as rapidly as the materials arrive. Meanwhile, the troops will remain in tents.

HEAT

In this hot, dry season the daytime temperature was sometimes as high as 120 degrees. To temper the heat, intensified by reflection from the white sands, many innovations were tried. To reduce the temperature inside the tents, a common method was to line the roof with salvage parachutes. This was effective, but there was scant relief for the equipment operators and others working outdoors. The soldiers wore tropical sun helmets and were allowed to remove their jackets and work in T shirts. Operations were arranged in two 10-hour shifts, one from 1 to 11 a.m., and the other from 3 p.m. to 1 a.m. This allowed the units to rest during the heat of the day and the shifts to receive the benefits of early morning and evening coolness.

Salt tablets and drinking water were liberally used by all personnel. In the first three months of operations, the engineers had no heat casualties.

SECURITY

When the unit had completed its defenses, the perimeter facing north was about 3 ½ kilometers long. Observation posts were placed at points of vantage, and the line was reinforced with triple roll concertina, foxholes, and sandbag-covered machine-gun positions.

The southern perimeter, facing Cam Ranh Bay, was protected by bunkers, and walking posts kept watch at night for infiltration of the enemy from the sea. Guarding the perimeter quickly settled down to a routine task, interrupted occasionally by long-range sniper fire. The large number of soldiers required for security adversely affected the engineer work, until July 12 when elements of the 1st Infantry Division came ashore and secured the peninsula, releasing the engineers for construction.

Temporary Road as First Constructed

PRESENT PROGRESS

The population of the peninsula comprises some 200 fishermen and farmers living in the villages of Ap Thuan Xuong, Thon Cam Ranh, Thon My Ca, and Vung Dua. These people live and work in the primitive fashion of their ancestors.

The village officers of Cam Ranh were very cooperative. Since the arrival of the Americans, no Viet Cong activity has been encountered in the village. The inhabitants soon recognized that the presence of American troops could be a bonanza to them; consequently, they built bars, photo shops, tailor shops, restaurants, souvenir stands, laundries, and other establishments which catered to the soldiers' trade. After three months the effect is beginning to show. The villagers are better dressed; battery-powered portable radios and phonographs are in evidence, and there is now a market where previously there was none.

The engineers have made great progress toward developing Cam Ranh into a major logistics base which will store and ship the supplies needed by the combat troops. By November 1, over 30 miles of roads had been stabilized and opened; troop cantonment and storage areas have been established; an airfield has been repaired and lengthened for use by the CV-1 Caribou.

Until additional dock space is constructed, much of the unloading must be by LST and amphibious vehicles. A landing for LST's has been constructed, and many other facilities have been installed.

The jet air base at the north end of the peninsula, with one runway completed and surfaced with AM-2 aluminum landing mat, is under construction by a joint venture of civilian contractors but Army Engineer units are assisting by training Vietnamese to operate equipment, by building roads and laying floor slabs, and by helping with the heavy equipment. They have installed 8 miles of POL pipeline from the pier area to the air base.

Also at the north end of the bay, an Engineer Float Bridge Company is operating ferries to the mainland, where the 35th Group recently opened a new laterite quarry. The ferries are operating around the clock, hauling the loaded dump trucks from the quarry to the projects on the peninsula.

The problems which have arisen are unusual, but the experience will be of tremendous value in future operations.

TME

[1] Commanded by Col. William F. Hart, Jr. Group elements consisted of the 864th Engineer Battalion (Construction), commanded by Lt. Col. James E. Bunch; 584th Engineer Company (Light Equipment), commanded by Lt. Alan R. Sim; and the 513th Engineer Company (Dump Truck), commanded by Capt. Rellon Lore.

[2] Commanded by Capt. William A. Hokanson.

[3] Commanded by Capt. Jesse Tyson.

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A CONTRACTOR'S VIEW

By W. Stuart Potter

A basic necessity in the engineering and design of large projects in Vietnam is the ability to adjust quickly to changes in conditions. Without this flexibility, the military objective of providing interim operational facilities at the earliest possible date probably could not be met.

In order to design usable facilities for construction at the lowest possible cost in the shortest possible time, the major interrelated factors that must be considered by the contractor are time and the availability of materials, equipment, and labor. A most critical design problem is to obtain firm and timely criteria. This is complicated by sudden changes in strategy, continual expansion of the particular military mission, and procurement difficulties. Since speed is essential, it is not feasible to stop work during review periods. As a result, any major changes or delays during the review constitute a severe threat to the schedule. Relief from this problem will be afforded when some standardization of repetitive structures is achieved.

The experience of a contractor with the early development of the Cam Ranh Bay airfield, which will be the largest Southeast Asian air base, is probably typical of that at other Vietnam installations.

The contractor's[1] team of about 125 people, including at least nine different nationalities, approached the project in stages. The first efforts were concentrated on the design of a temporary tactical aircraft runway of aluminum matting (AM-2), with the barest essentials for support and operational facilities, quarters, and utilities around the runway. The only available topographic map of the site was at a scale of 1:5,000, with 5-meter contour intervals, hardly conducive to an economical design in establishing grades and alignment. But the runway was required as quickly as possible rather than as economically as possible. This was a typical situation in which the substitution of funds for time was advantageous.

Because of the need for speed the contractor must have a thorough knowledge of materials readily available in the local market, warehouses, and yards; in the Philippine Islands staging area; and in nearby countries. When a design project is started, the best possible use is planned for such materials. Other supplies that will take a long time for procurement are specified first and the requirements are sent to the purchasing agency as quickly as possible.

EQUIPMENT AND LABOR

A close working relationship must be maintained between the architect-engineering firm and the construction agency. If, for instance, the generators on hand are of 200-kw capacity, the power plant must be designed with these in mind. The design also must allow for changes in equipment availability. At the Cam Ranh Bay airfield where, because of insufficient land area, the approach lighting system was designed to extend out into the bay, it was assumed that a dredge would be available to place a fill for this purpose. Suddenly, the dredge was needed elsewhere on a more urgent priority, and it vanished, thus making it necessary to redesign for a pile-mounted approach lighting system.

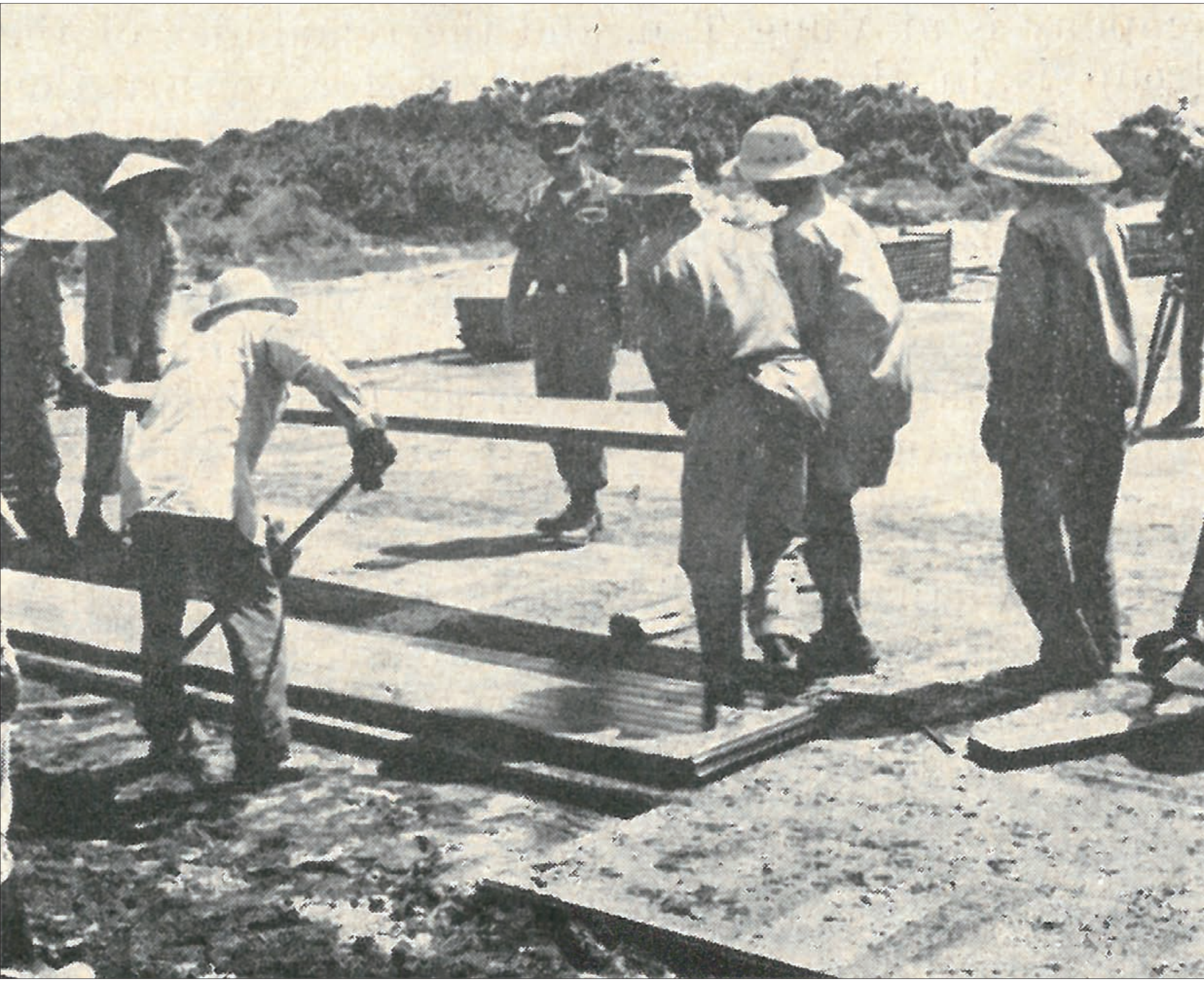
At the Cam Ranh Bay airfield where, because of insufficient land area, the approach lighting system was designed to extend out into the bay, it was assumed that a dredge would be available to place a fill for this purpose.

In the case of base course material for roads and runways, it was reported that there was sufficient quarry equipment to supply crushed rock. But the crushed rock later proved unavailable, and an alternate design using soil cement was provided. Cement shipments were then delayed. Where a base course could not be circumvented, a third design was prepared utilizing varying thicknesses of laterite, and reduced amounts of crushed rock and soil cement.

Also affecting initial design was the availability of labor. Many construction techniques which are considered routine in other areas of the world are unknown to the Vietnamese workers. Simplification of all installations and equipment is therefore a requisite for efficient employment of the local labor. The use of standardized prefabricated buildings wherever they will meet the criteria is advantageous.

CRITERIA

A prime difficulty in Vietnam airfield development is that of firm and timely criteria. For a large air base the criteria involve a great many specialty groups, and schedules are so urgent that the assembly of all criteria before the completion of the design is highly desirable. Transmittal of criteria in fragments is difficult to avoid, but can be a serious handicap. Constant changes in



Laying Aluminum Mats for Airfield Taxi Strip

equipment lists cause continual design changes to accommodate new requirements, particularly with regard to navigational aids, airfield lighting, and communications facilities.

Just as the designer must have knowledge of material, equipment, and labor availability, so must those developing the criteria. For example, the installation of side doors or other modifications to pre-engineered buildings, which have already been procured for Vietnam in quantity, is expensive and time consuming. If the requirements of various facilities can be satisfied with few modifications to standard buildings, time and money will be saved.

Other necessary criteria ingredients are an approved master plan of the entire facility and a description of its ultimate scope, so that planning for anticipated expansion and utilities may be done intelligently.

Reviews are essential as a check on criteria and design. Although problems caused by some changes are gradually being solved through standardization of some components, foundation requirements will continue to vary with soil conditions, utility systems will have to be adjusted to population changes, and petroleum, oil, and lubricant (POL) systems will have to be modified according to the type and number of aircraft to be supported.

The maintenance of a flexible and competent organization to cope with the continually changing conditions is the only way to ensure proper development and design of facilities to support the fighting men in Vietnam.

TME

[1] The Ralph M. Parsons Company.

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Army Troop Construction

By Col. J. H. Hottenroth, Corps of Engineers, United States Army

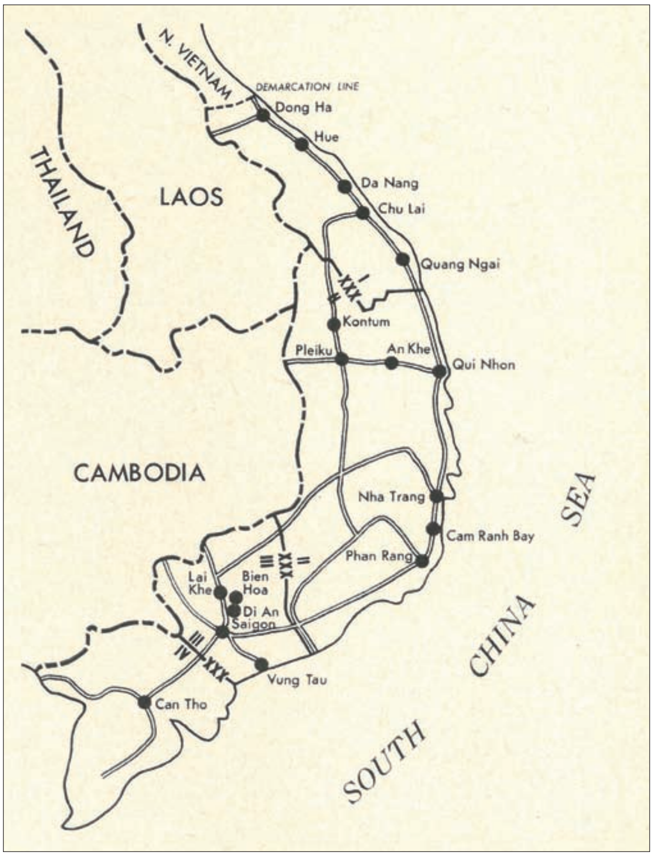
A major part of the military construction program in Vietnam is being conducted by Army Engineer troops. Since work was started by the 35th Engineer Group in the Cam Ranh Bay area in the summer of 1965, more engineers have arrived, deployed, and gained momentum in their construction and combat support activities.

The 159th Engineer Group was assigned in October 1965 to provide construction and engineer combat support within the Vietnamese III and IV Corps Zones. The combat battalions support tactical units. One combat engineer company is with each brigade or base of the infantry divisions, one construction company is at Vung Tau, and the remainder of the Group is in the Long Binh area for construction work in the Saigon-Long Binh region. The work in the divisional bases comprises cantonment construction with roads and utilities and facilities for C-130 four-engine planes, helicopters, and Army fixed-wing aircraft. Logistical facilities include hospitals, ammunition and supply storage areas, LST ramps, and POL installations.

LOCAL CONDITIONS

South Vietnam is divided into four corps tactical zones, each one under a Vietnamese Army Corps Commander who reports directly to the Central Government in Saigon. Under the four commanders are the chiefs of forty-three provinces, each one normally commanded by a lieutenant colonel. Within the provinces are the districts, similar to American counties, headed by district chiefs. Next are the chiefs of the eight to twelve villages in each district. The villages may include four to six hamlets, whose chiefs, in many cases, are appointed (others elected), but who will all be elected as the terrorist activities of the Viet Cong are suppressed. American military units have frequent contact, through the American advisers, with district and village chiefs, particularly in regard to civic action projects, such as support of orphanages and refugee settlements.

The 159th Engineer Group operates primarily in the area of the South Delta, where the elevation rarely exceeds 20 feet above sea level. This condition means a high water table which is a serious problem. It is difficult to find sites which are suitable from both the tactical and construction standpoints. Sites selected frequently have to be built up with 12 to 18 inches of firm material to provide the needed strength and stability, and large drainage structures are required to carry the heavy runoff from areas which have been stripped of vegetation.



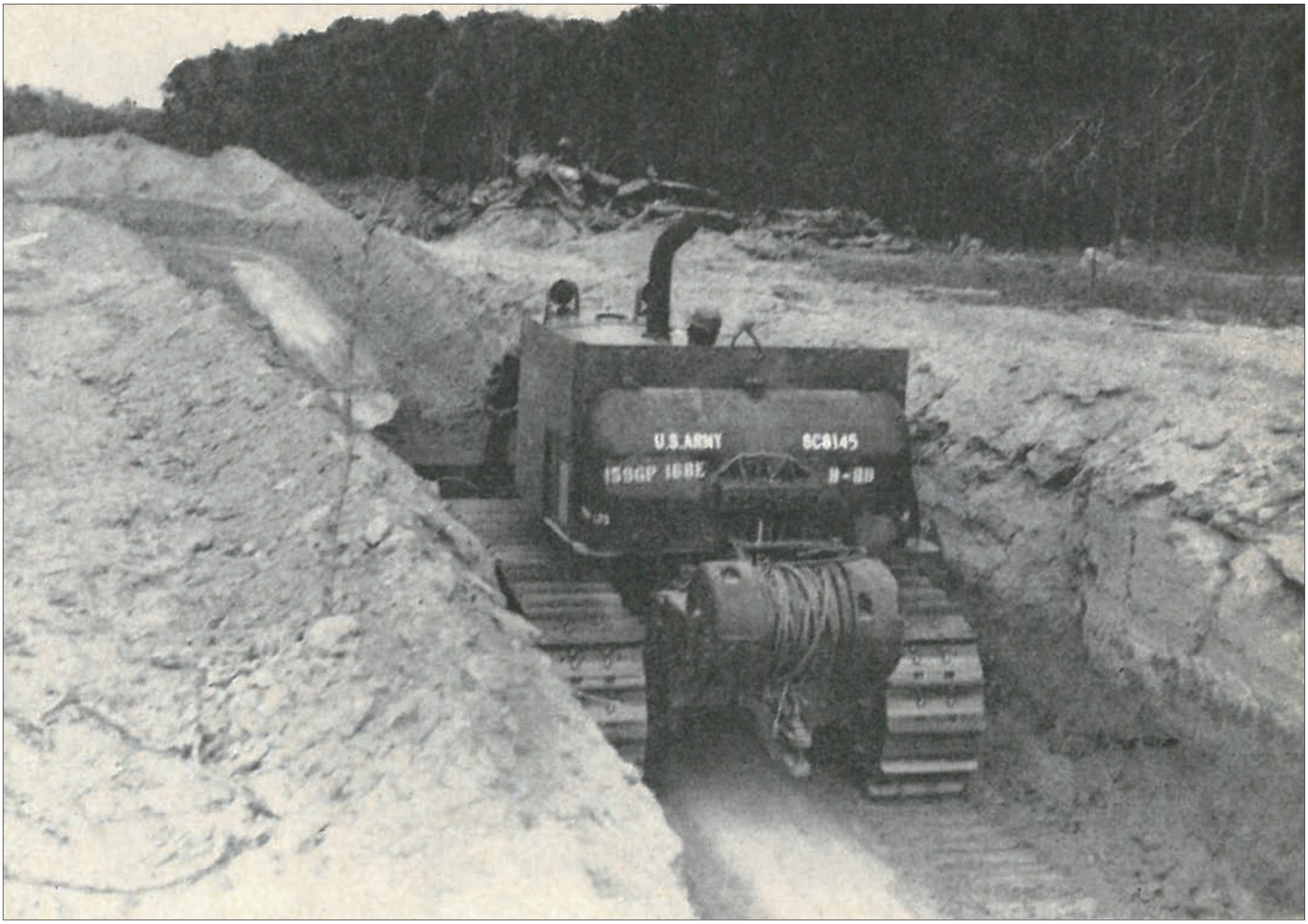
Corps Zones of South Vietnam.

Rainfall and extreme temperatures have a significant influence upon construction operations. January through March the rainfall in the delta is light, averaging less than an inch per month and falling on three days a month at the most. Twenty-four-hour extreme precipitation is 7.2 inches in June; approximately 5 in September, October, and November; and about 4 in April, May, and December. The highest temperatures are in February through May, with an average minimum of 91-94 degrees Fahrenheit and an extreme of 104. The minimum averages 74-76. In the remaining months the average maximum is 89, with an extreme of 99, and a minimum of 70 to 75 degrees.

The United States Army Vietnam (USARV) includes the 18th Engineer Brigade, the 1st Logistical Command, an Aviation Brigade, an Air Defense Artillery Group, a Signal Brigade, and Military Police Units. USARV is subordinate to the United States Military Assistance Command, Vietnam (USMACV), which also has Navy, Air Force, and Marine components. (In general, the 159th Engineer Group provides construction support to USARV, II Field Force and its Subordinate Divisions and Groups, and the 1st Logistical Command.)

The vast amount of construction required demands the controlled and co-ordinated use of contractors as well as of military engineer elements of the Army, Navy, Marines, and Air Force. The Director of Construction, MACV, manages all Department of Defense construction in Vietnam.

Contract construction for the Army is conducted primarily by a joint venture which operates under contract administered by the Naval Facilities Engineering Command, designated the contract construction agent in Southeast Asia. Some minor new construction is under contract to the 1st Logistical Command, and the infantry,



Earthwork on an Airfield at Lai Khe

artillery, and other units construct some of their facilities. With these exceptions, the military construction of the Army is by units of the 18th Engineer Brigade.

SUPPORT OF COMBAT UNITS

The first object is to support the fighting men to make their environment more usable, secure, and comfortable so that the combined arms team can devote its effort to the combat mission. This is in accord with the system of priorities and standards of construction developed to assure that engineer resources are applied where they are most needed, so that a unit is able to shoot, move, and obtain the necessary supplies and facilities for effective combat operations. In order of priority, the engineer tasks are to clear and grub areas for incoming troops, to issue field fortification material, to clear fields of fire, and to provide water supply points. Further down the list are the provision of hospitals, ammunition storage areas, communication facilities, and so forth. This priority list is the basis for the allocation of resources.

Related to priorities are the standards of construction. Bases are developed with heavy reliance upon self-help by the using units, so as to advance progressively to Standard 4, as described below. Standards of construction are:

Standard 1: An unprepared site, with no access other than a trail.

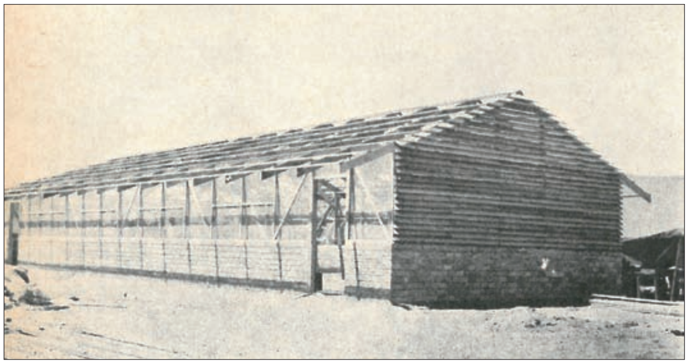
Standard 2: A site cleared by engineer units and provided with minimum access roads. The using units erect tentage.

Standard 3: Included are floored buildings for infirmaries, kitchens, administration and storage, and showers. Floors are added to the tents used for housing. Interior roads are stabilized but not surfaced. Water is distributed to infirmaries, kitchens, and showers. Electricity is distributed to buildings. Burnout latrines are installed.

Standard 4: This is the limiting standard of construction without specific approval from MACV. It progresses to framed tents or austere framed buildings for housing. Floored buildings are authorized for other purposes such as mess halls and morale and welfare facilities. Electrical distribution is extended to tents. Progress to this standard is largely a matter of self-help.

LOGISTICAL FACILITIES

The Long Binh area is being developed as a major logistical complex with maintenance facilities and with open covered storage for all classes of supplies. This development has involved the removal of many units and large tonnages of supplies from the Saigon area. The construction of storage facilities has had to keep pace with the arrival of shiploads of supplies which were moved directly from the landing to the storage areas. One of the main elements of this depot is an ammunition storage area under construction.



(Left) Rough Work for Heavy Equipment Operating at a Borrow Pit near Phan Rang (Right) Tropical Building Constructed by Engineer Troops at Di An

Another major facility is a 400-bed evacuation hospital consisting of 60 vertical-wall quonset buildings on concrete slabs, arranged normally in X-shape clustered of four, with the center portion used as a nursing station to serve four wards. This project is particularly noteworthy in that it was ready for the reception and treatment of patients approximately 45 days after the ground was broken. Also at Long Binh, 34,000 square feet of administrative buildings for a major headquarters were built in a period of about 50 days. Logistical facilities under construction at Saigon and Vung Tau include POL pipelines and bolted steel tank farms. At Vung Tau, LST ramps and timber pile piers are being installed and an onshore connection for a DeLong pier is being planned.

During the season of heavy rainfall (which varies from one region of Vietnam to another) it is impossible to construct roads or hardstands until the ground has thoroughly dried.

OPERATIONS

Many important aspects of the operations of the 159th Engineer Group are typical of engineer work in Vietnam. One such point is the dispersion of the companies of each battalion. The line companies of the combat battalions have been assigned distinct construction projects at separate location. Of the nine sites at which elements of the Engineer Group are deployed, it is practically impossible to reach five of them for command, inspection, maintenance, and liaison purposes except by air. This condition taxes the limited air transport capacity of the engineers.

Interference with construction by the enemy and by heavy rains is a serious problem. Enemy action has been limited to harassment in the form of sniper fire and mines and booby traps of various types. During the season of heavy rainfall (which varies from one region of Vietnam to another) it is impossible to construct roads or hardstands until the ground has thoroughly dried. Heavy monsoon rains also delay building construction and damage incomplete buildings of linings are not covered with sheathing materials before a downpour starts.

Base development planning is another important operation. Engineer units are responsible for advising installation commanders on base layout from a construction standpoint, and for assisting with the survey for roads and drainage. Subsequently, architect-engineer firms design the central electrical distribution systems and water storage and distribution facilities.

The engineers also must obtain, manage, and haul construction materials for their projects. Only laterite and rock are available locally in sufficient quantities. Virtually all other construction materials must be imported from the United States or from Korea, Japan, and Malaysia. Hollow clay brick and small quantities of hardware and electrical and plumbing items may sometimes be obtained on the local market. The engineers must allocate the available construction materials among the various projects according to their priority. This pertains to facilities being constructed by units doing their own work (self-help) as well as to projects being constructed by the units of the 159th Engineer Group. The problem of assuring that jobs are not held up by lack of construction materials is a real challenge to company and platoon commanders and supply officers.

Maintaining construction equipment in operating condition is a vital necessity. In secure areas, equipment is operated two shifts daily, seven days a week. This heavy usage and adverse soil conditions cause deadline rates somewhat higher than those incurred in American garrison or training operations. Well-qualified maintenance warrant officers and noncommissioned officers are an important asset to each unit. The spare parts consumption is also greater than that expected in the United States, and the prescribed load lists are often inadequate.

Finally, when construction materials are used in permanent, semipermanent, or even temporary buildings, they are chargeable under the MCA Program; hence, all such materials must be accounted for. As a result, the construction units must record costs of materials, estimate man-hour requirements, and report construction progress as a ratio of man-hours utilized to total man-hours expected. Vietnamese man-hours utilized also must be recorded for each project.

Military engineer construction operations are stimulating to the professional military engineer. He has to contend with problems of short construction deadlines, material shortages, equipment problems, weather, and enemy actions. The experience in Vietnam indicates that he is getting the job done successfully in support of the combat arms team.

TME

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Phan Rang Air Base

By Maj. Donald A. Haas, Corps of Engineers, United States Army

One of the main American operational air bases in Vietnam is at Phan Rang. It houses the 366th Tactical Fighter Wing of the Air Force and is the base of the 1st Brigade, 101st Airborne Division of the Army.

The Phan Rang complex comprises interim facilities as well as the more permanent facilities for sustained operations. The construction of the expeditionary interim facilities and some of the more permanent ones is assigned to the 62d Engineer Battalion (Construction) and the 554th Civil Engineer Squadron (Heavy Repair). The Naval Facilities Engineering Command is the contracting agency for permanent facilities.

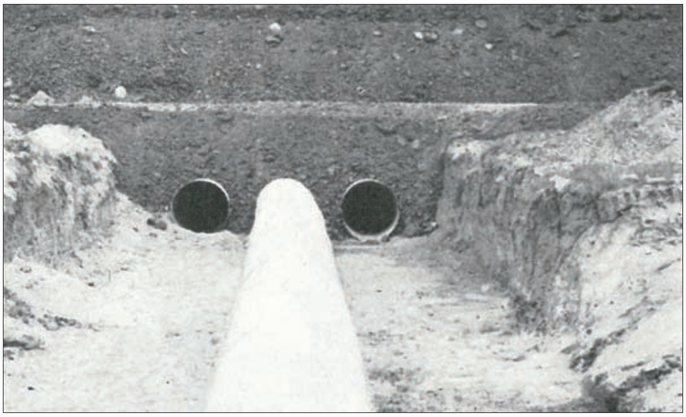
The expeditionary airfield includes a 10,000-foot AM-2 mat runway and accompanying taxiway, a PSP (M-8 matting) cargo apron, and over 800,000 square feet of AM-2 mat fighter apron. Other facilities are a POL system extending from the tanker off-loading terminal in the South China Sea to the fighter apron, and a large maintenance and storage area for the airstrip. The 62d Engineer Battalion also was assigned to support the over-all development of the Phan Rang area including the rehabilitation of the existing Phan Rang airstrip and the design and construction of cantonments.

The date for occupancy by the Air Force was established as March 15, 1966. All requirements were completed ahead of schedule, and the airfield became operational on March 14.

AIRFIELD CONSTRUCTION

Construction started on the Phan Rang complex in September 1965, when Company D, 62d Engineer Battalion, was sent there to establish the base camp and begin site preparation by constructing interceptor drainage ditches and clearing the ground. The base topographic survey had not been completed and it was not until October 15 that plans were received for the grade and alignment of the runway, taxiway, and apron.

The area for the base complex is fairly level and the soil is an impervious silty clay. As a result of the heavy rains of the monsoon season, water not only remained on the surface, but also formed in deep saturated pockets of organic material. This high moisture content of the soil delayed progress on the earthwork and seriously limited the trafficability of heavy engineer equipment. Since the material was too wet and soft to work with scrapers, the pockets were opened and extensive drainage ditches were cut. As the threat of heavy rain was ever present, each pocket had to be cleared and backfilled at once. Cranes with clamshells and front loaders were used to place the waste in dump trucks. After the first rains in September and October, a period of relatively good weather followed until December and much progress was made on the earthwork. The runway was cleared and stripped, and the select base was being placed when, in mid-December, the heavy monsoon rains again set in. Nearly 9 inches of rain fell during a ten-day period. Although there was no major damage to the construction areas, many days were lost during and after the rains because the sites could not support the heavy equipment.



Massive Drainage System under Runway

The new year brought good construction weather. By early January the runway subgrade was complete, and the base course was being spread and compacted over the entire 10,000 feet. The base of the airstrip consists of 12 inches of select borrow material compacted to a minimum CBR of 15. Continuous CBR tests were taken during construction with results exceeding design criteria. Work also progressed on the taxiway and apron and the massive drainage system. In one section, three 48-inch culverts cross under the runway in an old swale area. Approximately 16 feet of fill were required over this culvert alone.

Because of the high deadline rate of equipment in the battalion and the lack of repair parts, the equipment of the contractor[1] was incorporated into the expeditionary runway project in January 1966. Until mid-February, when the contractor was assigned the construction of an ammunition storage area, most of his equipment on the site was committed to the project. The equipment was operated by the contractor's employees during the day shift, and by military operators at night. The amount of earth moved or hauled on the airfield in the five-month period from mid-October 1965 to mid-March 1966 was 1,390,000 cubic yards, an average of 10,000 cubic yards per day.

AM-2 MATTING

Although the earthwork for the runway was far from complete in January, it was decided to start placing the AM-2 matting well ahead of schedule so that it could be completed on time, working at a normal rate. The hot, dry daytime temperatures of 100 degrees or more were a factor influencing this decision. Night operations were not feasible because the supply of electrical generators and flood lighting was insufficient for work on all projects during the night shift, and, since earthwork was the most critical operation, all available lighting was placed in support of it. Another factor necessitating daytime matting operations was the use of indigenous laborers who worked from 7 a.m. to 6 p.m. daily.

To provide a smooth, level surface for the aluminum matting and to act as a cushion between the matting and the base, a 2-inch layer of decomposed granite was placed on all areas to be matted. A large outcropping of decomposed granite was found just north of the end of the runway, and, by processing the granite through the shaker unit of the secondary crusher, an angular sand-like product was produced. The final grading of this leveling course proved to be the most exasperating and difficult part of the runway project. Since no tolerances were specified for this thin layer, the tolerances were established by the battalion, through experimentation and study, at ¼ inch in a 10-foot area. This tolerance held to a minimum the void under the matting and the deflection of the mat, thus providing maximum bearing surface. The fine leveling of the cushion layer was difficult for the grader operators who had been rough-grading for the previous four months, but after stabilizing the mold boards on the operators soon learned the fine touch.

The placement of AM-2 matting is a simple but tedious job. The only criteria for placement are a level surface and a right-to-left pattern.

This matting was underlain by a plastic-coated nylon membrane to waterproof the base course. The 40-by-100-foot sections of this material were overlapped at least 8 inches and glued with adhesive compound. Tests proved that the adhesive compound is soluble in jet fuel and gasoline, thus future spillage may be detrimental to the membrane. Since the Phan Rang runway was 102 feet wide, and the membrane was to extend 5 or 6 feet onto the shoulder, three sections of membrane were placed longitudinally down the runway.

Although the AM-2 matting can be placed in only a right-to-left pattern, it may be placed simultaneously in many areas or directions by using starter strips and 90-degree connectors. At Phan Rang, a starter strip was placed at the 5,000-foot mark of the airfield and matting was laid in a southern direction while earthwork continued on the northern half of the field. Since the matting should be placed perpendicular to the direction of traffic, 90-degree connections were used to change the directional pattern at the junction of taxiways and aprons. When the connectors are not available, aluminum end plates may be welded across the junction. From experience it was learned that the connectors should be tack-welded to the matting to prevent repeated traffic from shifting the matting and dislodging it from the connector.

When the mat placements began there was virtually no information on the size or composition of the crew. Through a one-week period of trial and error, it was found that small crews of troops could more effectively place the matting while the Vietnamese laborers were adept at placing membrane and locking bars. The

(Top) Preparations of the Site for Runway Concrete Anchor
(Left) Nylon Membrane Being Placed on Runway Prior to Laying Mat

American crew consisted of four men—two to place the mat panels, one to place locking bars and spacer bars, and one to assist with crowbar an mallet as needed. The jobs were rotated among the crew during the shift. The number of small crews naturally was dictated by the size of the project and the number of placement areas being worked at any one time. An additional crew of approximately twenty Vietnamese laborers under the supervision of one American noncommissioned officer placed the membrane and then followed behind the mat placement crews to clear away remaining end plates and braces. Another crew of ten indigenous laborers disassembled the AM-2 bundles. Americans operated the lowboys, forklifts and cranes for matting resupply.

Three placement crews backed up with the labor units were able to lay over 500 linear feet of runway (50,000 square feet) in a 9-hour shift. On the last day of matting operations, crews working in relays placed nearly 1,200 linear of runway in a single shift. Based on experience in this operation, an estimate of 2,000 square feet per hour per placement crew (with support as indicated) is used for schedule purposes.

To avoid movement of the mat runway surface, a concrete anchoring system was decided by the battalion engineers. The system also provided a common junction between the AM-2 runway and the PSP overrun. A 12-foot trench was cut at each end of the runway with the runway side sloped at 5:1, and six rows of matting were placed down the slope. Concrete was used to backfill the trench and bring the surface to grade with the runway and overrun. The sheer weight of the triangular concrete mass, 55 cubic yards or 110 tons of concrete, was sufficient to meet the anchor requirement. The junction between AM-2 and PSP was made by embedding the first row of PSP into the concrete anchor (12 feet from the end of the runway). This 12-foot gap was required in order to gain depth to countersink the anchors for the PSP. Aluminum end plates from the AM-2 bundles were welded to the runway and extended over the concrete so that jet blast would not peel out the thin tip of concrete at the junction.

Electrical and communication ducts have been placed under the runways and taxiways during the construction. Work is now continuing on the massive drainage system and shoulder construction.

FACILITIES

Two major cantonments built by the 62d Engineer Battalion were for the Air Force Grey Eagle Unit and the 1st Brigade, 101st Airborne Division. The Air Force cantonment was completed in January. The base camp for the 101st Airborne Division is being developed in phases according to USARV Standards of Construction.

The POL facility also is under construction. A base tank farm is being erected, and a similar farm will be constructed on the beach. Nearly 10 miles of 6-inch invasion pipeline has been placed between the beach and the tank farm on the base, and an interim 4-inch submarine pipeline was installed and tied into the overland pipeline. An 8-inch welded submarine pipeline and a four-leg mooring system are under construction. Aside from the storage farms and the submarine line, a functional POL facility was installed prior to the opening of the air base.

THE FUTURE

Many months of hard work lie ahead of the engineers at Phan Rang, and as the base develops so does the work involved. As new units arrive, the size and number of facilities must be increased. The combined efforts of the engineers at Phan Rang have made a good beginning, but as is true throughout Vietnam, it is, in fact, only a beginning in the construction required. TME

[1] Raymond, Morrison-Knudsen joint venture (RMIK).

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TURN KEY PROJECT at Tuy Hoa

By Maj. Gen. Robert H. Curtin, Director of Civil Engineering, United State Air Force

At an airfield site in South Vietnam a squadron of Air Force F-100's quietly moved in and began combat operations in mid-November 1966. The following month two additional squadrons joined the first. The latter two had deployed from Homestead Air Force Base, Florida, some 11,000 miles away. The maintenance and support personnel for these two squadrons had been airlifted from home stations by C-141 jet transports. The 31st Tactical Fighter Wing was thus placed in full operation at Tuy Hoa Air Base, about 240 miles north of Saigon on the shores of the South China Sea. By early January 1967, the air base accommodated some 3,200 military personnel and a construction contract force of 1,600 people. Eventually, approximately 4,000 military personnel will man the Tuy Hoa Base. But for the present the primary objective has been reached.

REQUIREMENTS

This objective grew out of a gradually emerging and increasingly urgent need for more air base facilities in Vietnam to reduce aircraft concentrations on existing bases and to provide base facilities for additional units already scheduled to arrive in the near future. Early in 1966 it became evident, in view of approved priority construction and work then pending, that the construction of a totally new air base on a very tight schedule was not feasible under the existing situation without diverting effort from critically urgent projects needed to maintain the current air operations. The objective then became one of producing air base facilities at the Tuy Hoa site on a schedule which would provide for interim operations by not later than the end of 1966 and sustained operations by mid-1967.

In examining the possibilities for attaining this, consideration was given to the existing and planned construction which must not be impaired, the shortages of skilled labor, the possible impact of proposed construction on the Vietnamese economy, the crowded conditions at ports, and any potential "competition" for supplies, equipment, and labor.

Gradually, the so-called "Turn Key" concept was evolved for the project.[1] This meant that a prime American construction contractor, under Air Force direction, would take on a packaged job of managing and supervising the entire task including design, procurement of supplies and equipment, transportation to the site, provision and support of the labor force, association logistic support, and on-site construction. The prime contractor would be responsible to the Air Force for practically all aspects of the project except the acquisition of real estate and area security.

The construction of new airfields in Vietnam had, in all but one case, included the interim or "expeditionary" facility, as also planned in Turn Key, which is a hastily built aluminum mat (AM-2) surfaced flying field supported by a minimum of other facilities. This provides for the earliest possible operational use pending the completion of more substantial works which are designated as "facilities for sustained operations" (or "sustained facilities"). At the earlier new bases, extremely heavy operations over longer periods than initially planned had required extensive maintenance and repair work on the hastily developed (AM-2) surfaces to keep them in operation. To avoid this at Tuy Hoa, the aluminum matting was placed on an 8-inch soil cement base to reduce later maintenance repair and permit subsequent retention in service if needed.

The AM-2 mat airfield facilities include a 150-by-9,000-foot runway, a parallel taxiway 75 feet wide, and some 165,000 square yards of apron, with their lighting, markers, and barriers. A control tower, operations buildings, and a communication facility were included for operational support. At first, a mobile tower and portable navigational aids were to be used. POL was to be handled through a 300,000-gallon "bladder system" until welded steel tanks were ready. An airmens' dining hall and troop tent camp were planned to meet minimum housing and messing needs. Small warehousing, minor utilities, and roads were also a part of the expeditionary phase.

MANAGEMENT AND CONTROL

To avoid the potential problems of cost increases and completion date slippages that could impede a major construction program, the Air Force developed for Turn Key a new system of construction management called "Planning and Management Control." It is a prediction, tracking, and control procedure for managing the key ingredients of the whole project from initial mobilization tasks in the United states through the completion of construction.

The conventional system of line-item progress reporting and cost distribution against individual line items was set aside in favor of a system of identifying progress or delays in all areas that make up the project together with a system that pinpoints all cost elements in relation to total cost. As an example, in mobilization activities, the tonnages of required equipment, materials, and supplies were plotted on a required time scale and the actual shipments were measured against the prediction track on a weekly basis. Tonnages shipped and delivered over the beach were predicted and tracked continuously to spot any choke points in the supply line. The build-up of the labor force; the construction of contractor's facilities such as the labor camp, warehouses, and shops; and quarry development were all closely controlled to assure mobilization within the allotted time.

The major cost elements that account for the actual expenditures were estimated, and prediction curves were plotted for the purpose of tracking and identifying problem items at the earliest date. Some of the major elements affecting total cost which are controlled continuously are: construction equipment, surface transportation, air transportation, engineering, labor payroll, construction materials, building modules, camp operation, overhead, and dredging. This sort of breakdown permits accurate and rapid identification of costs and the application of necessary controls to stay within budgeted amounts. Simplified line-item cost reporting will not provide the control required.

Critical Path networks, developed in the early stages of the project, provide the basic source data for the individual prediction and tracking charts. The system has been most effective in showing at a glance how the job is progressing and where the potential bottlenecks lie.

The Air Force management organization is composed of a Program Director's office at Headquarters Seventh Air Force in Saigon, a project office in New York to supervise design and mobilization activity in the United States, and a resident engineer unit at Tuy Hoa to supervise the construction. The total Air Force organization comprises less than fifty people. The New York office has now been reduced to a few procurement specialists.

DESIGN

In design, throughout the project, simplicity and rapidity of construction have been emphasized. For structures, exclusive use has been made of standard-size modules of pre-engineered buildings. Utility systems have been kept as simple as possible. Primary power plants were adapted to diesel/generator units, furnished from deactivated missile sites, and provided with distribution systems for use with transformers and cable already available.

The sustained operational facilities (concrete pavements) were for use by all Air Force jet fighter aircraft and transport support aircraft, thus providing for flexibility in using forces.

The contractor's facilities were planned and sited so that they could be integrated into the base facilities when completed.

The equipment for the project was tailored to the specific job requirements and peculiarities. Although it was feared that adequate equipment might not be obtained within the short time prescribed, all equipment was marshalled ready for shipment in 45 days after the award of the contract. This included earthmoving machines, paving equipment, batch plants, crushing plants, cranes, draglines, vehicles of various types, and a supply of spare parts.

Dump bodies for the gondola railway cars for hauling aggregate from the quarry to the airfield were fabricated almost overnight and shipped with the first boatload of equipment. The early and efficient delivery of the equipment had much to do with the timely completion of the expeditionary airfield.

LABOR AND MATERIALS

Because of the heavy demands placed upon the skilled labor in Vietnam and the difficulties of finding and obtaining entry permits for large numbers of workers from other countries, it was decided to rely almost exclusively upon American skilled labor. By requiring that a large percentage be multi-skilled personnel the American force was set at approximately 700. This figure, so far, has proved to be an accurate estimate of the labor requirement. Despite the prospects of a 70-hour work week in a brutal climate at an isolated location, the necessary labor force was mobilized and moved to the site on time.

Approximately 300 Philippine stevedores handled the off-loading of ships and delivery of equipment and materials over the beaches, and some 600 Vietnamese workers were employed effectively on the project.

The principal purchasing functions for the project were conducted in the contractor's office in New York. Orders for material were made concurrently with the design development so that early shipments of critical materials could be made directly to the site, and delays on items requiring long lead time could be avoided. A small purchasing office was also established in Taipei, Taiwan, to process purchases within the Far East. Pre-engineered buildings, POL tanks, water tanks, piping, and electrical and mechanical equipment were purchased in the United States and shipped from Gulf Coast ports. The major material purchases from another country were some cement shipments from Japan.

The absence of port facilities near Tuy Hoa, when the project got under way, necessitated the delivery of equipment and materials across the beach by the invasion/assault method, with cargo from deep-draft ocean vessels being lightered in barges and landing craft onto the beach adjacent to the construction site. During the monsoons and high seas, the unloading operations were moved 22 miles south to the protected waters of Vung Ro Bay. Then the landing craft and barges made their way up the coast to the mouth of the Da Rang River, where an entry channel and turning basin were dredged into a sheltered area behind a sand spit. When the job is finished, more than 150,000 tons of materials and equipment will have been delivered to Tuy Hoa.

CONCLUSIONS

From the experience gained so far in providing operational air base facilities in a minimum of time and at a reasonable cost, several significant conclusions should be cited.

All other conditions being equal, the most effective management and organization is one that provides continuity from the earliest planning stage through to the completion of construction. This can be effected only through the assurance that the key people who supervise the planning, design, and mobilization activities will then move to the site to continue with the execution of the construction.

To obtain the greatest benefit in accelerated construction, design changes at field level must be held to the absolute minimum. To do otherwise causes delays in completion and severe impact on the supply pipeline and ultimate costs.

The ability of the contractor to compress delivery of equipment and materials into the shortest possible period of time during the early mobilization phase is the key to successful completion. If this effort fails, there is no possibility of recovery in a situation similar to that at Tuy Hoa. The equipment and materials must be on the site ready for use when they are required.

The proficiency and dedication of the personnel charged with the accomplishment of the project will finally determine its success or failure.

The proficiency and dedication of the personnel charged with the accomplishment of the project will finally determine its success or failure.

The lessons of Turn Key are not new, but the experiences on the project served to revalidate and emphasize such elements as: the importance of dynamic top-level management, the vital need for expedited planning and concurrent procurement of long-lead-time items, the advantages of a highly skilled and flexible labor force, the requirement for proper and reliable equipment, and, above all, the good relationships between people resolved to do a good job.

TME

[1] With the concurrence of MACV, CINCPAC, and JCS, the Secretary of Defense, on May 27, 1966, authorized the Air Force to proceed with Turn Key. On May 31, 1966, the Air Force awarded a letter contract to Walter Kidde Constructors, Inc., of New York.

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CH-54 "Flying Crane" Lifting Construction Equipment for the Dusseau Airfield

Airmobile Engineer Support for Combat

By Maj. Gene A. Schneebeck and Capt. Richard E. Wolfgram, Corps of Engineers, United States Army

When the infantry jumps into a new battle area in an isolated region, it is only a matter of time before this must be followed by a logistical complex consistent with the size and momentum of the battle action. In early April 1967, the 1st Cavalry Division (Airmobile) was ordered to take over a portion of the 1st Corps (Marine) sector in southern Quang Ngai Province, Vietnam. Because of the tempo of the operation and the required tonnage of logistical supplies, such as ammunition, rations, and JP-4 jet fuel, a logistical support complex was needed at once.

Long before this operation, the Duc Pho area had been viewed by the 8th Engineer Battalion as a potential airfield site, and had been reconnoitered early in March 1967. At that time a centerline azimuth was selected, a general estimate of earthwork was calculated, and decisions on equipment for such construction were made. Since Duc Pho was outside the Division's area of operations at that time, the plans were filed.

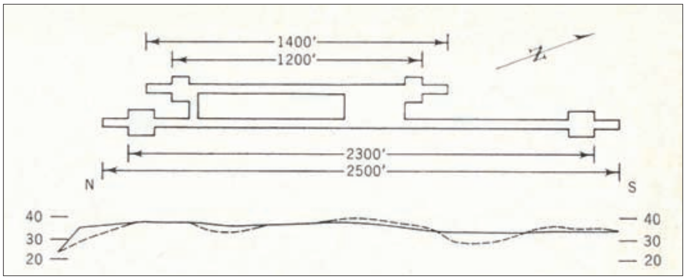
In the early morning hours of April 7, 1967, the 1st Cavalry Division (Air) was ordered to move a brigade into the Duc Pho area, and the 8th Engineer Battalion was simultaneously ordered to construct a C7A (Caribou) airfield there within one day and extend it to a C-123 airfield in two more days. A simple port facility on the South China Sea coast and a 6-kilometer land line of communications (LOC) connecting the two were also required. The previous reconnaissance report on the Duc Pho airfield was promptly reviewed, and by dawn that morning plans for the move were completed.

DUSSEAU AIRFIELD

The Headquarters and Headquarters Company was assigned to construct the airfield and a squad from Company A was attached for pioneer engineer support. The construction equipment of the First and Second Equipment Platoons of Headquarters Company was rapidly prepared for airlift. At that time, Companies A and B each had one D6B dozer committed in the forward area. These machines were also prepared for airlift from their respective locations. Late in the morning of April 7, a survey team was airlifted by a UH-1D to Duc Pho and began laying out what was to become Dusseau Airfield. At noon, the airlift of Headquarters and Headquarters Company began, and by midafternoon one TD-340 bulldozer, two D6B bulldozers, two graders, one scraper (grader bowl), one vibrapactor, two ¾-ton dump trucks, and two ¼-ton trucks had been brought in to Duc Pho by eight CH-54 (Flying Crane) sorties and nine CH-47 (Chinook) sorties and assembled. Aircraft were also engaged in a simultaneous airlift of 155mm and 105mm artillery batteries, so all the construction equipment for the project could not reach the site the first day.

By evening, the airfield was staked out on a magnetic azimuth of 19 degrees and the two D6B's and two graders began stripping the 18 inches of loose silty overburden from the runway. The TD-340 and scraper were put to work digging hasty protective positions in the company bivouac area. The equipment was operated throughout the night under the lights of vehicles and a floodlight set. Although this did not please the marines who had experienced nightly sniper and mortar fire for the preceding three months, the only thing that disturbed their sleep that night was the rumble of the equipment. By dawn the Caribou runway was half completed.

The equipment crews were rotated. The work continued throughout the day, and additional engineer equipment arrived. One D6B



(Top) D6B Used as "Push Cat" for Tractor and Scraper (Bottom) Figure 1. Dusseau Airfield. Plan and Profile (Right) The Completed Dusseau Airfield

bulldozer, three tractors, two 8-cubic-yard pans, two graders, one scraper, one double-drum sheepsfoot roller, one self-propelled pneumatic roller, and a maintenance truck were moved in sixteen CH-54 and five CH-47 sorties, and were assembled and placed in operation. After 24 hours during which 7,000 cubic yards of earth were moved, the 1,400-foot compacted-earth C7A airfield was complete. Work continued throughout the next night to lengthen the runway for C-123 aircraft. By the time the C7A strip was declared operational, the entire 2,500 feet of the C-123 runway had been stripped of overburden. When the first C7A landed at noon on April 9, the runway was 1,800 feet long.

That day, Caribous began delivering sections of 36-inch culvert and the squad from Company A began to assemble a 165-foot length to carry a major drainage channel under the airfield. The heavy equipment continued the cut, fill, and compaction operations even though hampered by heavy aircraft traffic. By the evening of April 10, the installation of the culvert was all that remained to complete the airstrip. The two scrapers cut a trench through the drainage channel while the squad completed the culvert assembly. Because the drop from the culvert invert to outlet was only 0.3 foot, the culvert bed was carefully prepared by hand under the watchful eyes of a survey team working by flashlight. Two bulldozers slowly moved the culvert into position and pushed it into the trench. The culvert was backfilled and compacted and, by dawn, the compacted earth C-123 runway, 2,500 feet long and 50 feet wide, was complete. (See Figure 1.) In a 72-hour period, helicopter transportable equipment had moved 25,300 cubic yards of earth.

Shaping and compaction operations continued to improve the runway surface throughout the day and the Dusseau Airfield was classified as a Type-I C-123 strip. The airfield met all the criteria of a Type-II C-123 strip, but a barrier at the north end, which could not be moved because of a local village, restricted the glide angle so that only 2,000 feet of the airfield could be used. The following day, a parking area for three aircraft was constructed adjacent to the west side of the runway. The area surrounding the airfield was landscaped and a 16-foot control tower was airlifted to Duc Pho by a CH-47.

THE SECOND RUNWAY

A second C7A runway was required to allow continuous operation of fixed-wing aircraft while the 39th Engineer Battalion lengthened Dusseau Airfield for C-130 use. On April 13, construction of this runway began. The edge of this strip was placed 145 feet west of the center line of Dusseau Airfield so that it could be used as a taxiway for the future C-130 airfield. An additional squad from Company A was airlifted by CH-47 to Duc Pho, and both squads began to relocate 1,000 meters of barrier that cut diagonally across the proposed runway. The fougasse and claymore mines were cleared from between the two lines of triple standard fence and, with the aid of two bulldozers, the fence was removed. Construction of a new barrier progressed rapidly across the open terrain, and was completed by nightfall.

Since there was no need for speed in the construction of this airstrip, work was conducted only during daylight hours. By the evening of April 15, after 24 working hours had been spent moving 7,000 cubic yards of earth in stripping and cut and fill operations, the runway was complete. The following morning the two runways were connected by a taxiway at the south end and by an extension of the parking ramp on the north end. That afternoon a C7A landed on the new runway and Headquarters and Headquarters Company prepared for airlift back to its base.

BRIGADE ENGINEER ACTIVITY

Meanwhile, by April 9, Company B (-) had moved by air to Duc Pho to support the 2d Brigade of the 1st Cavalry Division (Air) which had deployed for Operation Le Jeune. Nine CH-47 sorties were required to move six ¾-ton dump trucks, three ¼-ton

trucks, and personnel. One platoon was placed in support of the 1st Battalion, 5th Cavalry, which was conducting search and destroy operations in the hills southeast of Duc Pho. This platoon supported the infantry by sending mine sweep teams along with the units searching the territory dominated by the Viet Cong. Many enemy cave complexes and tunnels were found and destroyed by the demolition teams.

At the brigade base and site of Dusseau Airfield, Company B engaged in numerous general support tasks. The fine soil of the area presented an extensive dust problem to helicopters. In addition to the safety hazard of limited visibility, the angular soil particles rapidly eroded the helicopter engine turbine blades. Three asphalt distributors, a crane, and a 2½-ton dump truck were flown to Duc Pho by two CH-47 and four CH-54 sorties and the company placed 38,000 gallons of asphaltic dust palliative on parking and refueling areas in a period of ten days. The company also constructed helicopter revetments and 150 meters of pioneer road at the top of a hill using hand tools and demolitions, installed 5,500 meters of triple standard concertina barrier, and built a 30-foot timber bridge as a civic action project.

One of the 8th Engineers' airmobile water points had been airlifted to Duc Pho on April 8. The only suitable local source of water was in insecure territory, so Company B conducted a mine sweep along 500 meters of road to the water point every morning. In one three-day period, a 250-pound bomb with an 82mm mortar round booster, three 105mm rounds, one 155mm round, one 106mm beehive round, and two claymores were found emplaced as mines along the short route to the site.

The Second Equipment Platoon (-) of Headquarters and Headquarters Company was attached to Company B on April 16 to conduct base development work. The base plan had been devised by the 8th Engineer Battalion with the 2d Brigade and the Division Support Command. The two D6B bulldozers and two graders remained at Duc Pho to construct a two-lane road encircling the airfield and to improve existing roads within the base complex. The next day the equipment was placed in support of the 39th Engineer Battalion and pioneered the opening of 2 kilometers of the road linking Duc Pho with the South China Sea. On April 19, Company B was airlifted from Duc Pho. The Second Equipment Platoon (-) stayed to assist the 39th Engineer Battalion until April 25 when its remaining units were airlifted from the site.

CONCLUSION

During the time that the 8th Engineer Battalion was employed at Duc Pho, the 39th Engineer Battalion landed on the coast of the South China Sea and, after a joint reconnaissance with the 8th Engineer Battalion, began construction on a road inland to Duc Pho. By the time the airmobile engineers had completed their tasks, the 39th Engineer Battalion was moving its engineer equipment overland to continue the engineer work. In this respect, Operation Le Jeune was a classic example of the widely known, but seldom practiced, concept which calls for the employment of airmobile engineers at an otherwise inaccessible location and their subsequent relief by conventional engineer elements as soon as possible.

TME

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Viet Cong Tunnels

By Maj. Glenn H. Lehrer, Corps of Engineers, United States Army

While it is generally known that the term "tunnel rat" refers to soldiers in Vietnam who search and destroy the Viet Cong tunnels, few people know much about the typical Viet Cong tunnel. During Operation Cedar Falls in January 1967, Army Engineers[1] explored, plotted, and destroyed over 10,900 yards of Viet Cong tunnels and tunnel complexes in the "Iron Triangle" of South Vietnam. The engineers found the construction of these tunnels ingenious and their uses imaginative. It was necessary to devise special techniques for their detection, exploration, and destruction.

CONSTRUCTION AND FEATURES

The Viet Cong require very few tools and little training for the construction of their tunnel complexes. Labor is normally provided by workers who actively support the Viet Cong movement, and by civilians who have been charged taxes by the Viet Cong in excess of their financial means and are forced to work out the assessment. Sandbags or baskets are used to carry the dirt from the dug face to the nearest exit. "Bucket-brigade" techniques speed the operation. Disposal exits are dug every 100 to 200 feet to limit the extent of the bucket brigade and the number of laborers to man it. These disposal exits are closed and sealed off after the tunnel face has gone far enough beyond them. Reed mats covered with mud are used to conceal the disposal exit on the inside of the passageway. Most of the structures are not reinforced because the cohesive soil of the areas and the root network of the dense vegetation provide the strength required. There are few tunnels in areas of little vegetation and noncohesive soil, but where they do exist they are reinforced with timbers, logs, and bamboo. To avoid detection, the spoil is rarely piled near a disposal exit. Instead, it is either dumped in a nearby stream or spread in thin layers under trees at a distance from the exit. In a short time vegetation covers the newly spread earth.

Since rain and flood conditions could make death traps of the tunnels during the monsoon season, the Viet Cong have all but eliminated this threat by placing entrances and air holes on high ground. Wherever possible, they locate the entire complex above the local ground-water table. Where this is not possible, passageways of upper levels are sloped to entrances of lower levels so that any water seeping through the walls of tunnels or into air passages will fill the lower levels first.

Entrances and air holes are cleverly concealed at the bases of trees, in thick underbrush, under logs, or even in the sides of wells. In some instances openings have been found underwater in the bank of a river or stream.

(Left) Military land clearing in the thick vegetation of Vietnam is a major operation in uncovering hiding places and tunnels of the Viet Cong. Ambush sites and tunnel complexes thus are denied to the enemy. (Below) Team Member at Exposed Tunnel Entrance Receiving Information Telephoned by Tunnel Rats Inside

When an entrance to a tunnel is found, it is often difficult to enter because it is usually built for Vietnamese users and is no more than 18 inches in diameter. This is why the smallest soldiers are selected as tunnel rats. Beyond the entrance the passageway (which expands to about 2 feet wide and 3 feet high) consists of a series of straight sections 20 to 50 feet long, joined at various angles to one another, forming a zigzag trace. This pattern is advantageous in hiding the Viet Cong from observation while escaping, and protecting him from shock waves caused by explosives dropped into the tunnel, from shrapnel of detonating grenades, and from projectiles of direct-fire weapons. It also makes it easier for him to ambush tunnel rats during their search.

The tunnels found during Operation Cedar Falls were at an average of 20 feet below ground surface, and had more than one level or depth. The upper level is used as the main travel route whereas lower levels serve as hospitals, as living, hiding, and training areas, and for numerous more permanent purposes.

The entrances to the lower levels are usually cleverly concealed trap doors in the floor of the upper level. They are difficult to find even using probing techniques. These doors are commonly made of wooden or metal wash pans or wood framework. Each hole made in the floor is shaped like an inverted cone frustum, with the sides of the hole conforming to the shape of the pan or frame with the small bottom end closed. The sloped walls of the hole receive the pressure of the pan or frame sides when someone steps on top of it and thus prevent it from collapsing. To conceal the trap door, the users fill the pan or frame slightly more than level with dirt prior to being emplaced. Once through the hole, the user replaces the "door" and taps the bottom several times to shake the extra dirt into the lips of the hole and thus conceal it.

In some instances tunnels seem to come to a dead end. This is a dangerous situation, for usually a trap door will be near the end of such a tunnel and will lead to the area below the passageway and up on the other side of the tunnel face. There is probably a hole in the tunnel face through which the enemy may observe the searcher coming down the dead-end tunnel. The Viet Cong will wait on the other side of the tunnel face and shoot those who are following him.

Entrances are usually some 150 to 900 feet apart (straight line distance) which means that the irregular trace of the tunnel is much longer. Air holes are placed every 100 to 200 feet.[2]

Rooms are sometimes found in tunnel complexes, especially in the lower levels and in tunnels which are for more permanent use. Rooms discovered in the Iron Triangle usually measured 5-by-5-by-5 feet. The dimensions are limited by the type of soil in which they are dug and by their depth.

USES

Among the many uses served by these underground mazes, probably the most common is to provide cover and concealment for Viet Cong soldiers, political cadres, and leaders. Headquarters can function, training may continue, and hospitals can care for the sick and wounded 24 hours a day. It takes almost a direct hit with a 750-pound bomb to collapse a tunnel 20 feet below the ground surface. In the Iron Triangle, 750-pound bombs from B-52 bombers hit within 50 yards of one tunnel passageway and did not noticeably affect it. Tunnels are used to store rice, weapons, and ammunition. Rice is sometimes buried in the floor of the tunnel in covered baskets with a thin layer of dirt over the top. Water is stored in motor vehicle inner tubes. Almost every tunnel entered during CEDAR FALLS yielded some of these stores in quantity plus many documents.

Small fires are used for cooking near air holes in some rooms. Candles or diesel lamps provide light. Some of the enemy chased out of tunnels in the Iron Triangle had not seen the light of day for two weeks or more.

In addition to providing cover, concealment, and secure areas for the support of guerrilla operations, some tunnels are used as concealed escape routes after ambushes or attacks on allied forces. Two tunnel complexes were discovered that were built for this purpose. Each complex was along a main avenue of approach and the actual firing positions were entrances to a branch of the main tunnel, which provided an excellent escape route for the ambush units. These two tunnel complexes differed from the others, having more than their share of entrances, fewer rooms, and fewer levels.

Tunnel complexes built primarily for escape and shelter are found in Viet Cong controlled hamlets. They consist of many separate one-level tunnels with one room usually for each hut in the hamlet. An entrance to the tunnel is commonly concealed somewhere in the house and an exit is generally some 50 to 150 feet away on the edge of the village. The exits are well concealed because they may be the only means of escape when a hamlet is surrounded by allied troops. One favorite place for an exit seemed to be the side of a well. The room in the tunnel provides protection and shelter for the family of the house if the Viet Cong decide to try to hold the village and it is subjected to artillery and small-arms fire.

The most extensive and the rarest type of tunnel complex could be termed a communication facility. It is used for Viet Cong headquarters, hospitals, political cadres, troop training, infiltration routes, and, in some cases, supply routes. It consists of many levels and rooms. Some of these complexes are miles in length. One found during CEDAR FALLS was 6 miles long.

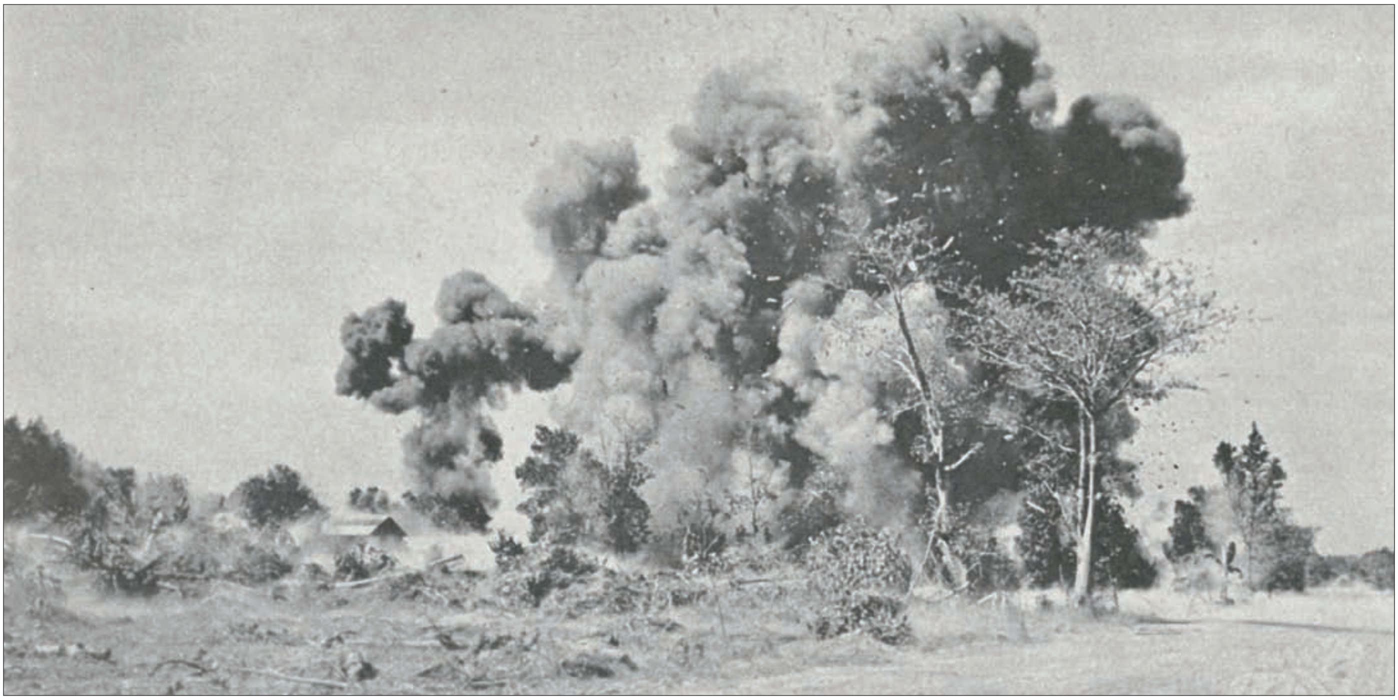
DETECTION

The first step in operations against tunnels is to find them. If one entrance is found and the tunnel complex is continuous, the rest of the entrances can usually be discovered. But the first entrance is the difficult one to find. Captured Viet Cong and local civilians are good sources of information on this subject. Another source is the American soldier who uncovers a hole in the ground while on a search-and-destroy mission. When an entrance or air hole is found, smoke generators are used to blow smoke through it into the tunnel. Observers are posted in the area to watch for smoke coming out of other holes. When new holes are spotted, they are marked and sealed so that the smoke cannot escape. This quick method of finding holes and entrances shortens exploration time, allowing teams of tunnel rats to enter the complex from several points simultaneously. This is also a good method of smoking out the Viet Cong from their hiding places. However, the usefulness of this method is somewhat limited. The small generator is effective in tunnels up to only 50 yards long and the large generator in tunnels up to only 500 yards, and the smoke must be cleared out before troops may enter even wearing protective masks. Also, the enemy may plug the tunnel, and the generator is then useless. Smoke grenades, unless used with an air blower, are ineffective in all but very short tunnels and shelters.

EXPLORATION

The work of the tunnel rats, with or without smoke, is to search, clear, and plot the tunnel complex. This is done by reporting by telephone to engineers on the surface the distance and direction of each leg of the tunnel and anything significant that is found. The tunnel rat must be observant and alert to avoid booby traps and ambush, and to be sure not to miss a trap door to a lower level or pass up a concealed supply cache.

The 173d Engineers employed two-man tunnel-rat teams. The first man carried a hand telephone and a compass. The second man



Blowing Up Entire Tunnel Complex with 1,500 pounds of TNT. The Complex was Next to a Main Road in the Iron Triangle

carried a roll of communication wire. Both men carried bayonets for probing, flashlights, smoke grenades, pistols, and protective masks. Each team should have at least two men at their entrance to the tunnel — one to keep contact with the team via telephone and the other to record the team findings, distances, and directions. The difficulty of crawling long distances in narrow tunnels with all this equipment makes it necessary to relieve the teams every hour or so. When a team emerges from a new exit, smoke grenades are used to reveal it to observers. A guard should then be set up near it. Viet Cong have been known to use searched sections of tunnels even while the exploration continued.

DESTRUCTION

There are several methods of destruction and denial of tunnel complexes. For tunnels within 10 feet of the ground surface, acetylene generators, air blowers (smoke generating devices), and a small explosive charge are used. The acetylene from the generators is forced into the tunnel by the air blower, with all tunnel openings sealed, and a small explosive charge is set off inside, which detonates the acetylene-oxygen mixture causing collapse of the tunnel. For tunnels deeper than 10 feet, explosive charges are placed in series at 100-foot intervals on the floor. Between these charges one or more 1-pound charges are placed, with sacks of a powdered riot-control agent on top of them. When the chain of explosives is set off, the tunnel collapses at 100-foot intervals and riot-control chemicals are blown into the walls between the collapsed sections. The chemical remains effective for from two weeks up to six months, depending upon how well the tunnel is sealed by the main charges. The 173d Engineers found that 2 pounds of TNT per foot of overburden concentrated at one point would collapse a tunnel in all soils encountered. These methods may be used in combination as necessary to destroy or deny use of the structures.

FUTURE NEEDS

Many new techniques are being explored for making the job of tunnel detection, exploration, and destruction easier. Possibly old tunnel complexes could be detected by airphoto interpreters finding changes in vegetation or soil coloration and shading patterns. Seismic detection devices similar to those used in geological exploration and instruments such as mine detectors modified to sense changes in density below the ground surface at depths of 50 feet are being studied. Exploration of tunnels would be easier and safer if tunnel rats could be equipped with infrared devices instead of flashlights which give away their position to the enemy. A radio transmitter-receiver for communication would eliminate the need for heavy and cumbersome telephone equipment inside a tunnel. This device could also be developed to provide a vertical fix on the tunnel rats so that their exact position could be known at all times.

The construction, concealment, and use of tunnels is one of the best indications of the ingenuity of the Viet Cong. As trenches in World War I and land and sea mobility in World War II were major elements of those wars, so the Viet Cong tunnel complexes are an important part of the Vietnam conflict. These complexes have afforded the Viet Cong secure and protected areas from which to operate. But the American Engineers, using imagination, ingenuity, and improvisation, have found effective methods to detect and deny to the enemy the use of his unique underground facilities.

TME

[1] 173d Engineer Company (Separate) of the 173d Airborne Brigade (Separate).
[2] It has been reported that the Viet Cong use small burrowing animals to dig their air holes. The animal is held in a cage which is opened on top and placed against the roof of a passageway. Supposedly the animal will dig his way to freedom on the ground surface and thus provide a very natural-looking air vent for the Viet Cong. The 173d Engineers found no evidence to support this theory.

First published in The Military Engineer, July-August 1968.

Figure 1. Erosion of Unprotected Ditch Banks.

Figure 2. Sandbagging with Soil Cement and Sand Mixture

Construction of a Delta Base

By Maj. Byron G. Walker, Corps of Engineers, United States Army

From an engineer's point of view, Dong Tam may be considered a terrific challenge, a golden engineering opportunity, a nightmare, a headache, a virtual impossibility, a large sea of mud, a big pile of dust, a dune of fine sand, or a blob of sticky clay. All of these things have been said of Dong Tam, and all with some validity.

Whatever else it may be, Dong Tam is, in fact, an urgently needed base camp to support tactical operations in the Mekong Delta of South Vietnam. When this need was felt in the summer of 1966, a site had to be found that would meet certain prerequisites: it had to be deep within the heart of strong Viet Cong territory so as to be a real thorn in their flesh; it had to be in a sparsely populated region, so that the land would be readily available to the United States and would involve a minimum of resettlement; and it had to have ready access to the system of waterways which are the major lines of communication in the Delta. This latter requirement has allowed the base to be used by the River Marine Assault Forces, the principal American combat troops in the Delta.

An area of approximately 600 acres was needed. There was no existing dry land available upon which to build a base that would meet all of these requirements, and it was recognized from the beginning that the base would have to be built by hydraulic fill. This necessitated a nearby source of satisfactory fill material.

The area selected was a rice paddy at the junction of a canal (the Kinh Xang) and a river (the Song My Tho, a branch of the Mekong), at a point 8 kilometers from My Tho, the second largest city in the Delta. The site is adjacent to a road and near a national highway which is a main route into the region. Extensive sand deposits lay offshore in the river. Under security provided by troops of the Republic of Vietnam, the first advance survey teams arrived at the site on July 21, 1966.

SOILS

The fineness of the sediments at Dong Tam is attributed to the slow velocity of the river, the lack of coarse materials upstream, and the distance the grains are carried from source areas. The soils are mostly hydromorphie silty clays (CL) or elayey silts (ML). Very little development of a soil profile (recent alluvia) is evident.

Seasonal desiccation and crusting during the dry season affect the rice paddy muck to a depth of 1½ meters. Soils below this level consist of weakly consolidated, soft, semifluid clays or silty clays with very low density, very low shear strength, and high moisture content. The clayey materials increase in density, stiffness, and strength with depth, with the variations to be expected in deltaic river deposits.

Standard tests were made concerning unit weight, water content, sieve and hydrometer analyses, Atterburg limits, classification, Proctor (modified) density, CBR, consolidation, and shear strength. Soils were classified in accordance with the Unified Soil Classification System. Compression tests on samples from the upper layer CL gave Compression Index values varying from 0.20 at a moisture content of 42 percent to 0.93 at a moisture content of 47 percent.

The fill material is a fine silty sand. Clay seams are evidenced by "clay balls" in the fill material. Samples from within the fill ranged from clay (CL), to silty sand (SM), and some fine poorly graded sand (SP).

DESIGN CRITERIA

The assumed elevation of the original rice paddy was plus 3 meters. Preliminary tidal data were available, and established the following elevations:

Tropical High High Water (THHW)= 3.71 meters.
Mean High High Water (MHHW)=3.30 meters.
Mean Sea Level (MSL)=2.40 meters.
Mean Low Water (MLW)=1.50 meters.
Low Low Water (LLW)=0.00 meters. (Datum)

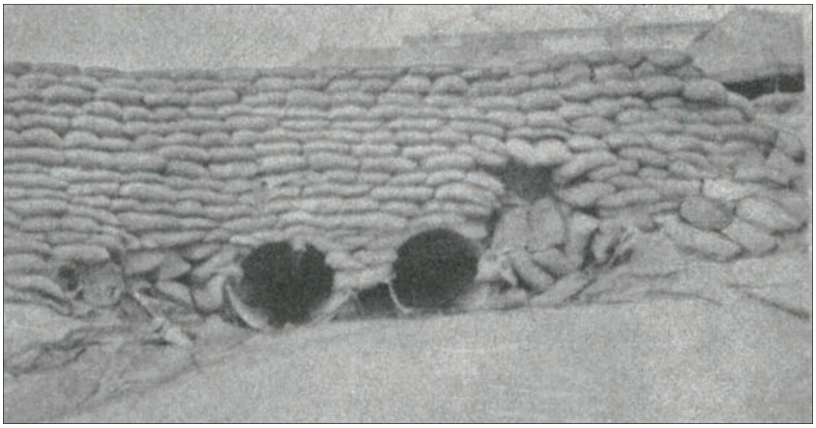


Figure 3. Failure of Sandbag Headwall

Figure 4. Erosion of 1:5 Slope

Based upon this information, the general design criteria were developed.

The area would be filled and rough graded to 5.8 meters. Overland grades were established at 2 percent for interior drainage, with elevations varying between 4.6 meters (0.9 meter above the highest water level) and 6.4 meters. Minimum invert elevation for exterior drainage culverts was set at 3.30 meters for positive discharge during normal tidal variations. Backwater was anticipated with the concurrence of high tide and tropical high high water, but would be of short duration. Ditch gradients were limited so that water velocities would not exceed 2 feet per second.

River side-embankment slopes would be kept at 5 horizontal to 1 vertical.

Dike slopes (up to 2 meters) would be kept at 1½ horizontal to 1 vertical, or less.

Settlements of some 15 inches were to be expected for 200-by-400-foot buildings with loads of 800 psf (such as sheds and open storage areas).

The 3- to 4-meter fill would be subjected to differential settlements due to consolidation of underlying soft clays, but shear failures in the fill zone should not develop for loads of 1 to 1½ tons per square foot over areas limited to 30 or 40 feet.

Heavy structures sensitive to differential settlements would probably have to be supported on piles.

Heavily loaded slabs should be free floating.

Raft foundation design should be given preference over separated footings.

DREDGING

The dredging operations under contract[1] began on August 1, 1966, when the dredge *Cho Goa* started cutting the turning basin. In September the dredge *Jamaica Bay*, a 30-inch 5,000-hp dredge, arrived and began removing sand from the Song My Tho to the fill area. The project was set back at least two months when, on January 9, 1967, the Viet Cong sank the *Jamaica Bay*. Operations were reinforced when the dredge *Hyun Dai Ho 1*, a 25-inch 2,000-hp dredge, arrived on January 24; and the *New Jersey*, a 30-inch 6,000-hp dredge arrived on March 10. In May, the *Hyun Dai Ho 1* was replaced by the *Hyun Dai Ho 2*, a 27-inch 4,000-hp dredge. The fill was to be completed in December 1967.

The Viet Cong harassed the construction from time to time. Four draglines, one truck, and two work barges were destroyed or damaged, in addition to other minor damage to engineer equipment.

TROOP CONSTRUCTION

With the filling of the southern portion of the cantonment area, construction got underway.[2] Many engineering techniques were involved and were complicated by the tactical requirements. The adverse effects of the abrupt change in conditions between the dry season (December-May) and the rainy season (June-November) were compounded by the necessity to work around the tactical units that used virtually every piece of high ground when the rains came. Most of the construction effort was taken up in combating erosion and the earthwork problems encountered during the rainy season.

DITCH STABILIZATION

The Dong Tam fines are susceptible to erosion by wind and water. Overland grades were kept at 2 percent or less to minimize water erosion, and some sort of bank protection was essential (Figure 1). Sandbagging ditch sides and headwalls (Figure 2) was one of the first methods tried for ditch stabilization. At first only sand was used, and the walls had a short life (Figure 3). When a 10 percent cement and sand mixture was placed in the sandbag, with only enough moisture so that a hand-squeezed sample would retain its shape without crumbling, the wall constructed (Figure 2) was much more stable and gave very satisfactory results.

The great drawback to this method was the large amount of manpower required (600 man-hours for 1,400 square feet). Next, the ditch banks were laid back on gentle slopes of 1:5 or less, but this did little to control erosion when left unprotected (Figure 4). Stabilizing these slopes with soil cement (10 percent cement) proved quite satisfactory as long as the soil cement shield was not fractured, but there is some tendency for undercutting in the ditch bottom and near headwalls. Only 25 man-hours were required for 260 square feet.

The next method tried was to put "shingles" of burlap over the ditch banks. The upper shingle was anchored in a V-ditch and backfilled at the road shoulder (minimum of 3 feet from the slope

Figure 5. Tractor Sinking in the Fill

edge). Wooden purlins, 2 by 4 inches, were anchored in the bank, and the burlap was tacked down in a shingle fashion. The bottom flap was anchored in the ditch bottom. The entire structure was then sprayed with RC-3 asphalt to seal the burlap and delay the decomposition of the covering. This method was one of the most promising tried, since 38,500 square feet were installed in 1,500 man-hours. T-17 membrane could be adapted to this technique. By using solidly anchored purlins and tight burlap, a uniform slope with no ponding was attained. But a puncture in the covering would result in disaster because of saturation, which would cause a mud slide, or undermining.

One of the later methods tried was terracing and seeding. Each successively higher retaining board was placed with a 1-inch overlap with the next lower board. The system worked well, and the rice (confiscated from the Viet Cong) grew vigorously. This section became one of the few green spots on the base.

A final and somewhat more sophisticated stabilization operation included concrete curbs with corrugated metal-pipe spillways and sodded slopes. This method bars traffic from the ditch slope and should prove most satisfactory, although 1,450 man-hours were required for 10,650 square feet of this type of protection. A system now under study is to shape and then gunite the entire ditch. The ultimate goal of each of these attempts was to make the homesick grains of sand happy in their new environment—rather than insisting upon their sentimental journey back home to their cozy river bed!

DUST CONTROL

Wind erosion is constantly evident and dust is as big an annoyance in the dry season as the mud is in the rainy season. Dust is a nuisance around mess halls, living quarters, and roads, and is unacceptable around heliports. Numerous control measures were tried at Dong Tam.

T-17 membrane was placed over the heliport areas. This is an excellent means of dust control and protection of the subgrade from moisture.

The area was sprayed with Peneprime, an asphalt soil stabilization compound.

A thin coating of sand-asphalt (using asphalt cutbacks) was placed.

The area was sprinkled with water.

A latex water emulsion, UCAR 131, was applied, leaving a film over the ground surface.

All of these methods were effective, although none held up under heavy vehicular traffic. The T-17 membrane was the most durable.

FOUNDATIONS

The deployment of military units into the Dong Tam Base camp required immediate occupaney of filled areas. Often heard was the comment, "We pitch camp at the end of the dredge pipe!" The areas, in their super-saturated condition, settled with vibration. Loads were frequently transmitted to layers susceptible to pore water pressures, resulting in "quick" conditions, sand boils, reduced shear strengths, and the sinking of equipment (Figure 5).

Excavations of whatever depth were soon filled back to the original elevation by upheaval from the bottom and failure of the sides. Thus, holes dug for signal and power poles had to be immediately shored with 55-gallon drums, and the poles placed and grouted. A delay of as much as 5 minutes in any sequence usually resulted in failure. Underground storage tanks were likely to appear suddenly above ground if their flotation was increased sufficiently by drawdown of their contents. Reinforced concrete collars were placed around the bases of such tanks to keep them down. Culverts also had to be rapidly installed and backfilled to keep the excavations from closing and to hold the culverts below grade.

BUILDING CONSTRUCTION

The combination of engineers, Vietnamese skilled labor, and "self-help" troop labor has built a cantonment complex of well over 150 buildings. All building construction (except hospitals and communication facilities) is of the temporary tropical type, with louvered outside walls and screening. Standard plans were used and simplified where possible. The primary difference in building construction in the Delta from that in the rest of Vietnam is the extensive use of sand cement. Since all materials must be shipped into the Delta, including fill rock and concrete aggregate, only footers have been placed using concrete aggregate. A sand-cement mix has been used for the interior floor slabs, with good results.

The standard two-story billet (4,320 square feet) could be built in seven to ten days, including the placement of concrete footers and sand-cement floors. One engineer technical advisor with the necessary equipment assisted the self-help troops in construction. Wall panels and roof trusses were prefabricated in the engineer yard, generally by Vietnamese carpenters. Using this approach, forty-five two-story billets have been built with self-help effort.

Because of the remoteness of Dong Tam, considerable work had to go into the construction of community facilities. A good example of this type of construction is the chapel-theater.

Dong Tam, with all of its various challenges and frustrations, will continue to provide engineers with valuable experience in Delta construction. Mistakes will be made. But, as always, the job will get done and the engineers will move on to another location. Perhaps the next job will be even more challenging, but at this point it is difficult to see how it could be.

TME

[1] By RMIK-BRJ (a combine of Raymond International, Morrison-Knudsen, Brown and Root, and J. A. Jones) for the Navy Officer in Charge of Construction for Vietnam.

[2] Company C, 577th Engineer Battalion (Construction) arrived in January 1967. In May, the 69th Engineer Battalion (Construction) assumed responsibility for over-all base construction. The engineer company on site was redesignated Company B, 69th Engineer Battalion, and was joined by Company C of the battalion. Other units participating in the construction were the 15th Engineer Battalion (Combat), 86th Engineer Battalion (Combat), 41st Engineer Company Port Construction), and engineer detachments of the 1st Logistical Command.

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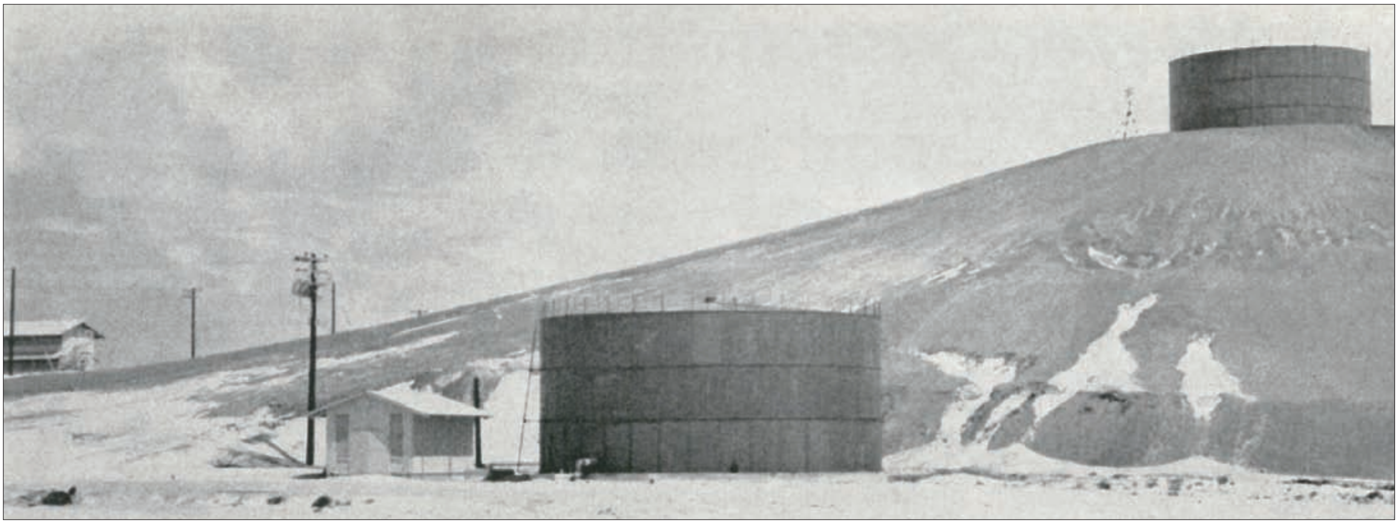


Water Systems for Air Bases, Southeast Asia

By Col. Clifton W. Bovee, United States Air Force

Many lessons have been learned in providing water supplies for the growing military air bases in Southeast Asia. It is recognized that satisfactory utility services are essential to air base operations, yet, by early 1968, nearly three years after the start of the military construction program in South Vietnam and Thailand, only a single air base, Tuy Hoa, had a programmed water system.

SITUATION

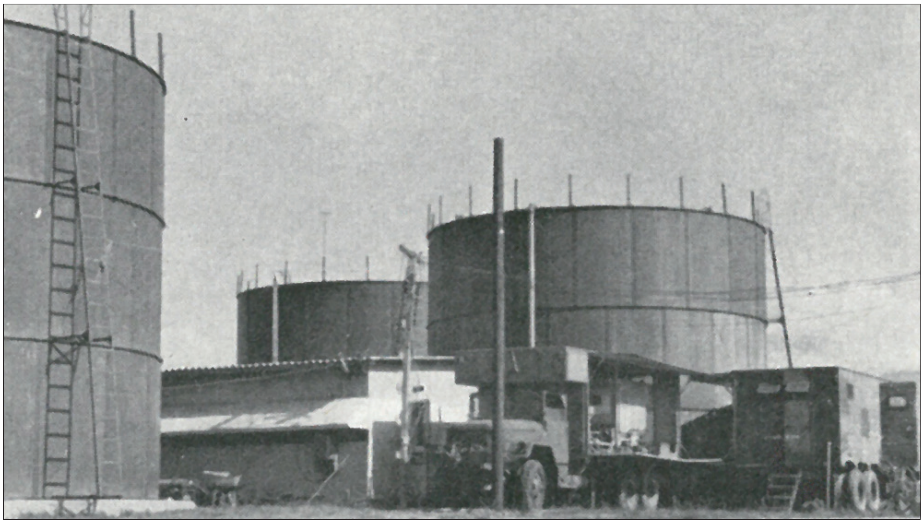
With the build-up of American forces in Southeast Asia and the construction of large air bases to support their operations, came a soaring water demand. Raw water is plentiful in Southeast Asia. Monsoon rains bring 50 to 115 inches annually, drained off by several major river systems and a maze of streams and man-made canals. Ground-water tables are near the surface in lowlands, with flooding commonplace during heavy rains. Along shore lines, sand deposits constitute aquifers with fresh-water lenses supported through recharge from rainfall and tributary watersheds.

The surface waters available for air base developments in Thailand and Vietnam are not heavily mineralized. Total dissolved solids are in an acceptable range between 80 and 200 parts per million. Chemical and radiological characteristics of significance for human consumption are well within the safe limits established for drinking water. The lightly industrialized regions contribute negligible industrial pollution. Thus, the waters are fairly soft, of good chemical quality, and do not require demineralization for general industrial uses.

On the other hand, physical and bacteriological characteristics of raw surface waters in Southeast Asia are extremely poor. While the low velocities in the meandering lowland water courses do not transport coarse sediments, the constant reuse of surface waters for rice irrigation keeps turbidity from fine silts at high levels throughout the coastal plains areas. Color from humic and tannic acids, lignins, and other organic substances is usually pronounced. Bacteriologically, these waters are heavily polluted. Indigenous populations live close to nature, and the low levels of sanitation prevailing in rural areas favor the transmission of water-borne disease. Flooding during the rainy season heightens these health hazards.

Characteristics of ground waters in Southeast Asia are just the opposite. Physical and bacteriological qualities of such waters from sources other than dug wells, galleries, and shallow wells are good, with an absence of color, odor, suspended solids, and pathogenic microorganisms. Chemical characteristics are frequently objectionable because of high iron content, sometimes accompanied by manganese. Total dissolved solids in the ground waters of Thailand and Vietnam tend to run from 160 to 400 parts per million, an acceptable range for domestic supplies.

Essential requirements for producing satisfactory water supplies



(Left) Cam Ranh Bay Air Base Water System — Part of the reconstructed interim water system showing the well and pump house, with individual chlorination facilities. Ground water is pumped from the coastal aquifer directly into the storage and distribution system. Elevated storage for the local area is provided by the upper tank. Several such independent systems are in use at the base.

(Right) Interim Water System, Phan Rang Air Base — This hilltop treatment plant processes water from a stream source. Six skid-mounted 3,000-gph diatomite filter water purification equipment sets are housed in the center building, augmenting the original two truck-mounted units.

for air bases in the Southeast Asia environment are apparent from these conditions. Surface water requires full treatment using clarification to remove suspended solids and microorganisms, followed by a polishing step such as filtration through fine sand. Ground-water developments usually require iron removal treatment. Prechlorination is indicated for water processing in Southeast Asia. With the surface waters, prechlorination materially assists both the conditioning and filtration processes, and reduces the danger of infectious hepatitis transmission. With the iron-bearing ground waters, prechlorination starts the iron precipitation process. Postchlorination of all supplies is essential for proper disinfection.

Utility services should not be considered secondary to the air operations which they support; they are an essential part of the whole installation.

INTERIM WATER SYSTEMS

With the exception of Tuy Hoa Air Base in Vietnam, the first water systems for new air bases and expansions of the existing bases were expedient installations.

In Thailand, deep wells and stream sources were used about equally. Deep wells at Nakhon Phanom Airport and Don Muang Airport produced about 0.25 a mgd at each base; eight deep wells at Korat Air Base produced 0.8 mgd, and thirteen deep wells at Ubon Airfield produced 0.8 mgd. No treatment other than chlorination was used in the Don Muang and Ubon systems. Diatomite filtration was added at Korat and Nakhon Phanom. Surface water development at U-Tapao Airfield began with the utilization of five standard diatomite filter units producing about 0.2 mgd of treated surface water. Automatic valveless filter units applying surface water treatment to water obtained from nearby irrigation water impoundments were used to produce 0.4 mgd at Takhli Air Base and 0.6 mgd at Udorn Airfield.

In Vietnam, ground-water developments were favored over surface waters for the initial air base water systems.[3] The Tan Son Nhut Airfield system began with five deep wells and chlorination treatment to, produce about 1.0 mgd. Cam Ranh Bay Air Base with five deep wells, Da Nang Airport and Bien Hoa Air Base with four deep wells each, Phu Cat Air Base with three deep wells, and Nha Trang Airport with five shallow wells all utilized ground water with diatomite filtration and chlorination to provide domestic supplies ranging from 0.4 to 0.7 mgd. Binh Thuy Air Base used an existing rapid sand filter plant of 0.2 mgd capacity. The Pleiku Airport water development pumped and chlorinated 2.0 mgd from a mountain lake source.

Tuy Hoa Air Base alone, of all the air base developments in Southeast Asia, did not have an interim water system. Instead, the Turn Key arrangement, under which this base was constructed, provided for a finished water system consisting of wells 60 feet deep in a coastal aquifer, a 0.7-mgd pre-engineered treatment plant for iron removal, gas chlorination, storage, and distribution.

Bacteriological safety of drinking water supplies was emphasized through strict chlorination requirements, but the general inadequacies of the interim systems became more pronounced each month. Production capacities were severely limited by the Army water production and purification equipment which was never intended to meet the needs of a fixed installation. Standard 3,000-gallons-per-hour diatomite filter water purification equipment sets were used in the systems utilizing surface or turbid ground-water sources. These units, which were expressly developed to remove pathogenic protozoa from raw water in areas where amebic dysentery is prevalent, provided excellent health protection but did not have the capacity to meet the water demands of developing air bases.

As the production capacity of these sets was reached more units were added. Manifolding of several units was common practice, with as many as eight used at Phan Rang, but this practice was soon limited by maintenance and operational control factors. Thereafter, the procedure was to use dual water supplies, with treated water reserved for domestic consumption and untreated supplies used for industrial, fire reserve, and, sometimes, latrine and shower purposes.

The use of the untreated deep well waters for interim air base supplies also became increasingly objectionable as facilities were completed and base operations began. The high iron content of most of the supplies made them unsuitable for general domestic and many industrial uses. Also, bacteriological safety in distribution

Table 1. Physical/Chemical Characteristics of Interim Drinking Water Supplies

Installation	*Characteristics Exceeding Permissive Limits**
THAILAND	
Don Muang Airport	Dissolved solids
Takhli Air Base	Turbidity
Korat Air Base	Lead and zinc
Nakhon Phanom Airport	None (satisfactory quality)
Ubon Airfield	Iron
Udorn Airfield	Manganese
U-Tapao Airfield	Turbidity and iron
VIETNAM	
Bien Hoa Air Base	None (satisfactory quality)
Binh Thuy Air Base	Turbidity and iron
Cam Ranh Bay Air Base	None (satisfactory quality)
Da Nang Airport	Turbidity, color, manganese
Nha Trang Airport	Turbidity, iron, manganese
Phan Rang Air Base	Turbidity, color, iron & manganese
Phu Cat Air Base	Manganese
Pleiku Airport	None (satisfactory quality)
Tan Son Nhut Airfield	None (satisfactory quality)
Tuy Hoa Air Base	None (satisfactory quality)

** Public Health Service Drinking Water Standards, 1962.*

was difficult to maintain since the plain chlorination provisions were not suited to the chlorine demands of the iron-bearing waters. When production capacity lagged, water rationing was necessary. Efforts to increase capacity inevitably were in the direction of more wells. More wells, in turn, compounded the interim utility system problems to the point where neither the consumers, the base engineer operators, nor the medical service public health authorities could be satisfied.

When water demands of the Southeast Asia air bases reached full development during the latter part of 1967, the interim systems were overextended with frequent breakdowns resulting. Overpumping of wells caused constant sanding troubles, and at some coastal locations loss of wells was threatened as salinities mounted through salt-water intrusions.

Analyses obtained by base medical units to determine the conformance of water supplies to the physical and chemical sections of the drinking water standards gave the results shown in Table 1 for late 1967.

PROGRAMMED WATER SYSTEMS

Master planning for each of the Southeast Asia air bases began with their mission establishment, and the facilities required were incorporated in the construction program. Master planning identified base water systems at the outset as required exterior utility services. On the other hand, Air Force programming covering theater of operations air bases lists water supply as an indirect operational support facility, following in priority essential facilities required for air operations. This listing tended to postpone the construction of the water systems. A scarcity of sanitary engineers in the design agencies contributed to the gap existing between need for and provision of these basic utility services. Source investigations and feasibility studies took inordinately long to complete. Long lead times required for procurement and delivery of the mechanical and electrical equipment for built-in-place conventional water systems added to the delay.

In Thailand, design work for the water systems was completed by late fall of 1967. Construction was underway in 1968 to provide complete 1-mgd surface water treatment plants for Takhli Air Base, Ubon Airfield, and Udorn Airfield. Source development proceeded for a similar 2-mgd plant at U-Tapao Airfield and procurement was begun for surface water treatment units for the 0.85-mgd Nakhon Phanom Airport system. Existing well supplies for Don Muang Airport and Korat Air Base were continued without major reconstruction.

Programmed water system work moved slower in Vietnam. High cost estimates discouraged programming complete new systems at some bases and the interim systems were reconstructed and continued. At Cam Ranh Bay Air Base, Phan Rang Air Base, and Phu Cat Air Base, the original contractor supplies were improved and distribution was extended to serve the bases.

The Turn Key project for Tuy Hoa Air Base was planned, designed, and constructed as a single entity through the management method of network planning. The Program Evaluation Review Technique resulted in each facility being completed by the time its function was required in relation to the air base as a whole. Thus, all utility services were complete and operable on the day the base was turned over to the occupying Air Force organization. This has proved to be the proper solution to basic utility service.

CONCLUSIONS

Programming of water systems for air bases in a theater of operations needs reform. Utility services should not be considered secondary to the air operations which they support; they are an essential part of the whole installation. The network planning technique which produced Tuy Hoa Air Base as a complete installation ready for operation on a specified date demonstrated that a complete water system can be provided along with the airfield itself.

Water quality should receive as much consideration as water quantity. Air base water system developments should provide the specific water treatment which may be required by the particular characteristics of the source used.

Pre-engineered package water treatment plant units are better for air base water system development in a theater of operations than conventional built-in-place waterworks. The continued use of Army field water purification equipment for this purpose is not satisfactory because of its limited capacity in relation to the needs of a fixed installation. Treatment units with capacity of about 0.5 mgd are recommended for air base construction, permitting dual units to produce the average daily requirement. Full surface water treatment should be provided including prechlorination and postchlorination. With the addition of separate detention, the same equipment could treat iron-bearing ground waters. TME

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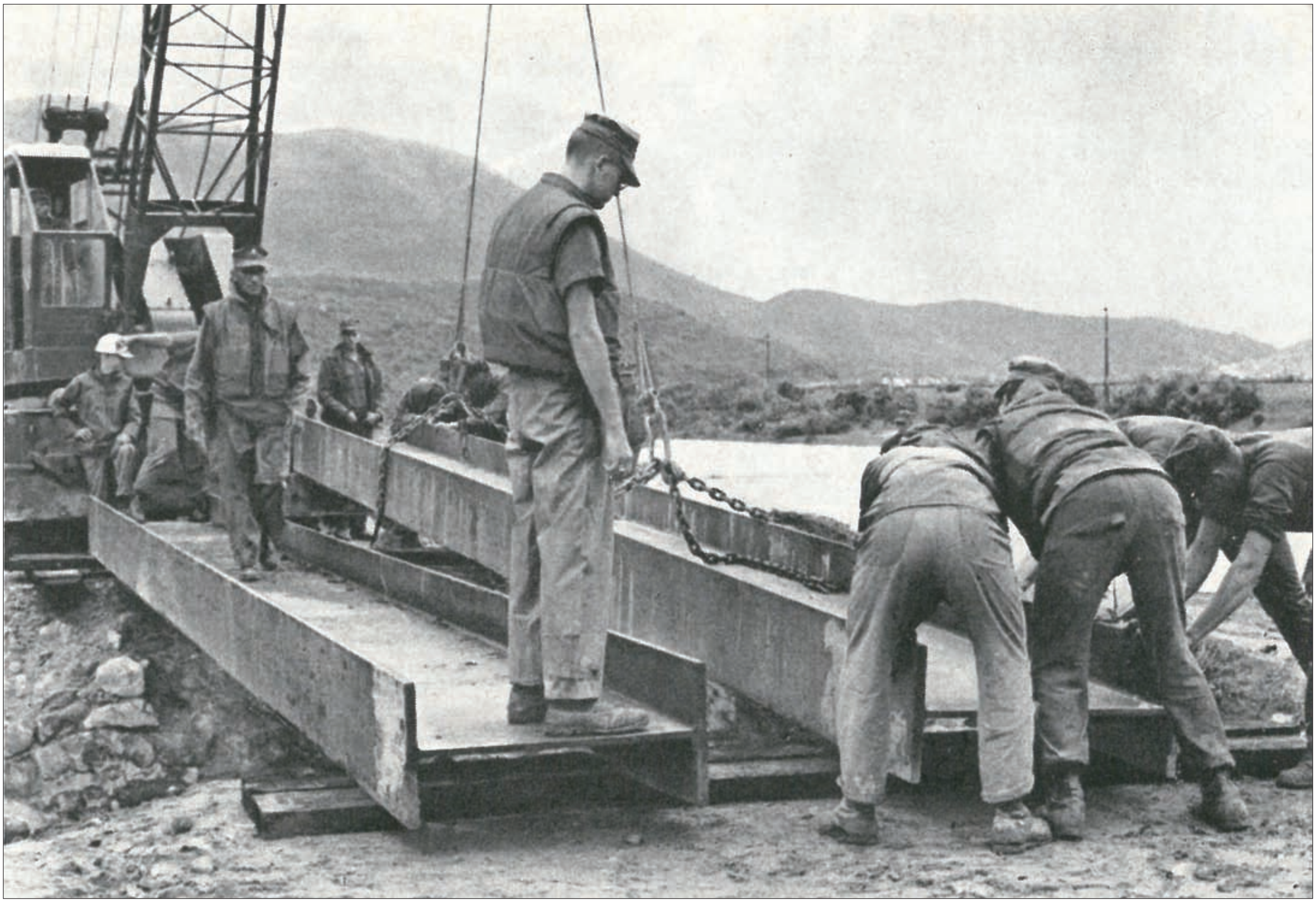

Figure 1. Seabees Lowering I-Beam into Place for Hasty Bridge Replacement on National Route One in Vietnam

Seabees' Hasty Bridge

By Lt. j.g. Warren W. Way III, Civil Engineer Corps, United States Navy

Build a Class 60 bridge in less than one day? This sounds like an impossible task. Yet, in Vietnam, with the Viet Cong and North Vietnamese constantly destroying critical facilities, such difficult tasks have become almost routine for the Seabees. When the monsoon rains caused washouts of small bridges across National Route One there was not time to replace them with standard timber pile bridges. As an expedient remedy, a bridge that could be built of available materials and installed in a matter of hours was designed by MCB-121. This structure, nicknamed the "Hasty Bridge," has been used several times by the Seabees to provide a quick span over which supply convoys could travel.

National Route One is the only means of north-south land travel in South Vietnam. It is used not only as a major artery for food for the Vietnamese people, but also as a major supply route for American Forces. In the I Corps, from Chu Lai to the Demilitarized Zone, the Seabees are responsible for keeping this road open to traffic. This is especially difficult because the road is one of the prime targets for Viet Cong and North Vietnamese harassment. Along the coast, the road is built on dikes through the lowlands, and blocks the natural flow of mountain runoff to

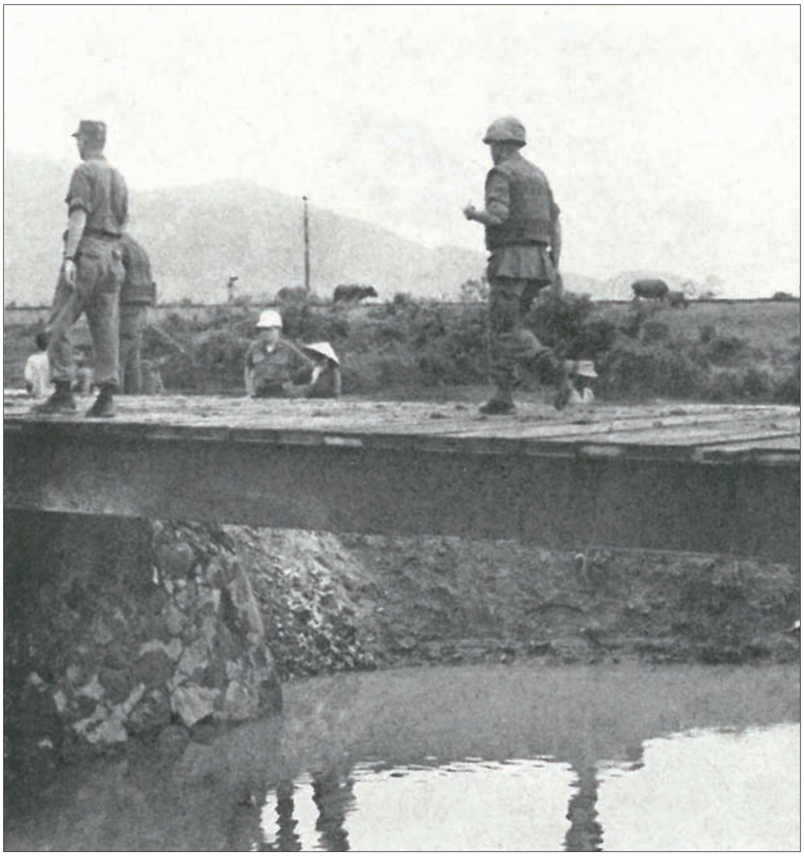

Figure 2. Hasty Timber Bridge

the Gulf of Tonkin. There are, therefore, many small bridges to allow water to run under the road. These bridges are very susceptible to enemy demolition, and, because of the great number of them, reliable security is impossible. When one of these bridges is blown, it is necessary to reopen the road as quickly as possible. Culverts can often be used, but are not always practicable because of high water, too large a span, or not enough time. The only other solution is a bridge which is quick and easy to handle.

Most of the existing bridges are of reinforced concrete arch construction. In practically every case when one has been destroyed, a substantial stone and mortar abutment has been left. Most of the spans are less than 40 feet (maximum span length of Hasty Bridge) and thus can be crossed with a single bent.

The Seabees have used several variations of the Hasty Bridge depending upon the materials available and the time allowed for construction. The first of the bridges was built about 10 miles south of the Seabee camp in Phu Bai. The design, collection and delivery of all materials and equipment to the job site, and construction combined had to take less than twelve hours to accommodate a convoy coming from Da Nang. The available structural members in this case were 36-inch wide-flange steel beams approximately 42 feet long. The 25-ton mobile crane which is standard MCB equipment could lift the beams and set them in place across the gap. Rough calculations indicated that three beams, lying flat across a 30-foot span, would provide at least the desired Class 60 capacity. Various size timbers were available for the decking.

Upon arrival, the crane was set on the near side of the destroyed bridge, and the beams were off-loaded from flat-bed trucks and lifted into place. To provide a bearing surface for the beams 3-by-12-inch timbers were placed on the road, parallel to and about 3 feet from the existing abutment. The beams were set with the flange surfaces vertical (Figure 1). The outside edges of two beams were set 12 feet apart, the finish width of the bridge, and a third beam was placed in the middle, and 3-by-12-inch planking was placed across and secured to 6-by-6-inch cleats. Later, 3-by-12-inch treads and 6-by-6-inch curbings were added. Gravel was used to form an approach at either end of the bridge.

The construction time, from arrival at the site until the first vehicle crossed, was less than five hours. This bridge remained in place for over a month without requiring maintenance. Its capacity was amply tested when the mobile crane moved out onto it and lifted a Vietnamese civilian cargo truck which had rolled off the road. The combined dead weight was approximately 45 tons.

The second Hasty Bridge was basically the same as the first, but because of traffic backed up several miles on either side of the span, time was too short to allow for similar decking. Steel beams of the same type were available and were quickly placed. But instead of adding planking on top, the beams were placed so that the wheels of most vehicles would ride between the flanges, and a layer of 3-by-12-inch planking was placed inside the flanges to form treads. It was necessary to include the middle beam, because in Vietnam many of the civilian buses are three-wheeled. This bridge was completed in 55 minutes.

Several days after the second bridge was installed, another was needed. This time steel beams were not available. The stringers were made from 12-by-12-inch timbers placed side by side on the existing abutment. Planking was nailed across the timbers and treads were put on them. There was special urgency for the rapid completion of this bridge because the Viet Cong were lobbing mortars at the site throughout the construction. A hasty timber bridge is shown in Figure 2.

The Hasty Bridges are not intended to be permanent structures; each will be replaced with timber pile bridges when time and weather permit. But when the Viet Cong hit, it is necessary to open Route One as rapidly as possible and the Hasty Bridge has proved to be a valuable tool in keeping a step ahead of the enemy.

TME

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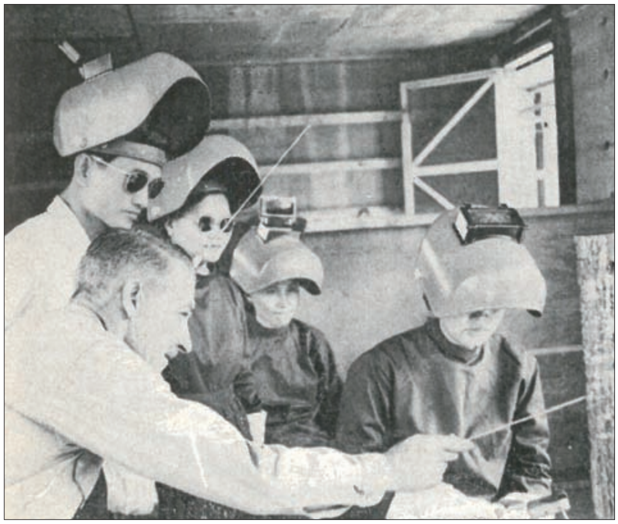
This was the beginning of the R&U installation at Lai Khe, about 40 miles from Saigon. Tents were—and in places still are—the R&U contractor's only facilities at many installations in Vietnam.

Civilian Repairs and Utilities in the Combat Zone

By Thomas E. Spicknall

The Vietnam war has added new dimensions to the use of civilian repairs and utilities (R&U) support of American military forces. The Vietnam R&U, or "Post Engineer," contractor operation is the largest ever established in support of troops engaged in a war zone. For the R&U contractor this operation for the Army on the battlefield has presented the challenges and rewards of a pioneer effort.

(Left) R&U Construction Crew Laying Warehouse Foundation at Vinh Long in the Mekong Delta—Guard Tower and Bunkers have been Built for Security in this Remote, Hostile Area. (Right) Vietnamese Women Being Trained as Welders—the Instructor for the R&U Contractor and a Vietnamese Interpreter-Assistant are Shown at the Left.

R&U in Vietnam has undergone a five-year evolution that closely parallels that of the American military commitment. The first Vietnam R&U contract[1] was let in May 1963, when the United States was maintaining an advisory force of approximately 5,000 men in the country. The purpose in bringing civilians into the combat zone was to relieve the advisors from nonmilitary tasks, freeing them to help the South Vietnamese meet the increasing Communist threat.

Lack of any but the most rudimentary programs of health or sanitation meant that the military bases where these services were provided had to be made into islands of health in a sea of disease and pestilence.

The contractor was to provide R&U services at six sites which were designated by the Army: the northern ports of Qui Nhon and Da Nang (with nearby Phu Bai); Nha Trang, on the central coast; Pleiku, in the strategic Central Highlands; Tan Son Nhut Air Base, near Saigon; and Soc Trang, a Mekong Delta provincial capital. The contractor began operations with five Americans, 10 Filipino third-country nationals, and 259 local Vietnamese.

The basic problems faced by the Post Engineer contractor in Vietnam fell generally into four areas:

Logistics.—As the build-up accelerated, supplies and equipment could not be poured into Vietnam in quantities adequate to meet the needs. Combat priorities strained military supply channels and clogged the inadequate port facilities. Moving materiel inland involved communications routes under Viet Cong control.

Communications.—Military installations, especially those in remote areas, were virtually cities under siege, surrounded by enemy guerrilla units. Early communications consisted of ordinary mail and occasional messengers. Installation managers had to rely on the military for supplies and on their own ingenuity to provide the services required by the Army.

Labor.—Being chiefly agrarian, Vietnam was lacking in skilled labor. Just as the American Army was involved in training Vietnamese troops, so the contractor was engaged in a training program for Vietnamese workers. Supervisor-teachers had to be found and recruited for this purpose.

Environment.—The tropical climate, varied terrain, primitive communications systems, and general social and wartime conditions contributed to the difficulties involved in establishing a large-scale, coordinated R&U program.

An additional factor was the large amount of minor new construction work required of the contractor. Post Engineer services usually are in a ratio of approximately 85 percent repairs and utilities work to 15 percent minor new construction (costing not more than $25,000 per project). At the height of the troop build-up this ratio was almost reversed. Troop facilities first consisted of tents, then semipermanent structures, requiring a steady program of so-called minor construction that grew to gigantic proportions. By mid-1964, Post Engineer work had swung to emergency defense construction. Bunkers, troop cantonment areas, sentry towers, emergency utilities systems, security perimeter lighting, power plants, and similar facilities were given top priority.

The military bases, in many ways like the early American frontier forts which were thrust into a raw and hostile environment, were nevertheless expected to have modern sanitation, entomology services, pure water, refrigeration, and other facilities. But no proper refuse or sewage disposal facilities were available; public health and sanitation programs did not exist; there was no safe city water system or reliable local source of electric power. All facilities had to be built or converted from old colonial structures. Practically everything had to be started from scratch.

COMMUNICATIONS

Possibly the greatest operational advance in Vietnam R&U has been in communications. The Vietnamese telephone system is completely unreliable. Communications between the contract management office at Tan Son Nhut Air Base and the field installations early in the war took days at best, depending on the speed of the mails or the fortune of cross-country messengers.

As the contractor's operation grew to include thousands of employees at scores of locations, effective communications between installations and central management became imperative. In October 1966, the Army authorized a high-frequency single side-band radio net connecting major installations. Today there are 29 stations linked by that net, and it in turn is connected with a 33-station VHF-FM net with 96 mobile units and 250 hand-carried radio telephones. Instantaneous communication between the management office and installations is now routine.

LOGISTICS

Logistics, probably the most difficult problem facing the contractor, has become manageable only within the last year with the arrival of large quantities of R&U equipment. Throughout most of the troop buildup, materiel was scarce. At the end of 1964, for instance, more than 250 equipment items had been approved for R&U use, but only about 3 percent were in the country. Construction materials were also scarce, and imaginative use had to be made of what was available.

As the American troop build-up went from 48,000 troops in Vietnam in June 1965 to more than 350,000 in June 1967, immediate nearby offshore procurement was mandatory.

One installation manager found that he could replace the broken clutch rod of a truck with the vehicle's mirror arm. Guy wire or the handles from rolls of concertina barbed wire were used as welding rods. To conserve sandbags, a standard wartime construction item which rapidly decomposes in the tropical climate, 10 percent cement was mixed with the sand. The bags then hardened as dampness set in, and held their shape even through the heavy rains.

Installations all over Vietnam used artillery shell casings and expended rocket tubes for drainage tile.

Fifty-five-gallon oil drums were used for shower tanks, peneprime spreaders, asphalt heaters, forges, pumps, burn-out latrines, sumps, and many other unavailable items.

An insecticide fogger, one of the most useful improvisations, was made by mounting a drum filled with 6 to 7 percent malathion insecticide in diesel oil (for killing mosquitoes) on a ¾-ton truck and spraying the poisonous mixture out with the exhaust from the vehicle. The insecticide is drawn from the drum by the partial vacuum in a line connected to the exhaust pipe just behind the manifold, and sprayed out under pressure of the exhaust. This expedient apparatus can spray up to 9 square miles of cantonment area per day, as compared with the 40,000 to 50,000 square feet covered by a manually operated fogger.

In other cases, the over-all shortage of materiel and R&U equipment forced the contractor to resort to a number of improvisations.

Subcontracting of R&U services was especially irksome. Tight controls had to be exercised to prevent such practices as the selling of garbage and trash to refugees, or failure to make full deliveries of fuel and water. Even when subcontractors did their work honestly, as was the case with most of them, they were not equipped for the efficient operation required to support the Army.

Subcontracting of R&U services is being phased out as new equipment arrives. This equipment was obtained—some after four years delay because of priorities—through an unusual procedure which authorized the contractor to handle the procurement of nearly $12,000,000 worth of equipment and supplies.

This greatly alleviated the R&U equipment shortage in Vietnam, but moving the materiel from ports of entry to the sites where it is needed presents serious difficulties. Chief among these is the necessity of moving supplies such as cement, lumber, and plumbing fixtures by military airlift. This means that these things, not normally carried by air, became subject to air movement priorities. But close liaison with military transportation authorities makes it possible for such R&U priorities to be assigned to meet special situations. Cement for bunker construction or a generator for security perimeter lighting thus may be assigned priority even over ammunition or fuel, depending on the immediate situation.

Logistics problems also have been alleviated by the assignment of two Caribou aircraft for R&U operations. Approximately 10 percent of the 10,000 tons of R&U cargo moved monthly is carried on these two aircraft. (In terms of bulk tonnage, military water craft carry 60 percent and military land transport, 20 percent.)

A secondary supply problem resulted from emergency procurement of equipment which is not standard to the military system, and from the contractor's authorized equipment, much of which consists of commercial rather than military engineer/construction equipment. This means that repair parts are not found in the military supply system.

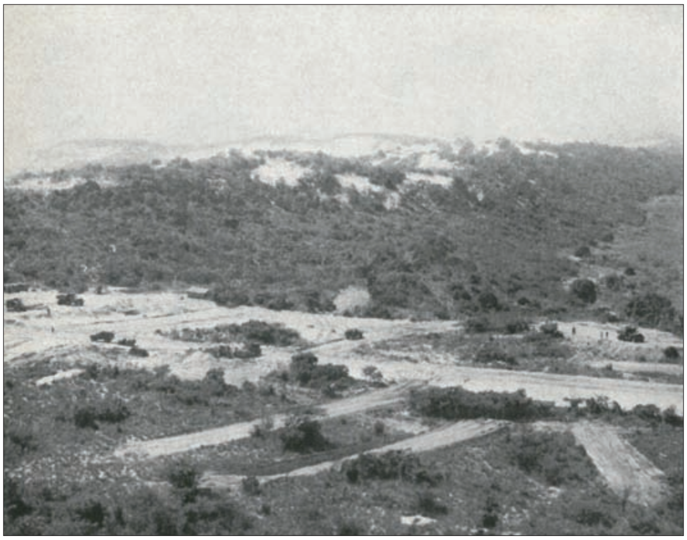
As the American troop build-up went from 48,000 troops in Vietnam in June 1965 to more than 350,000 in June 1967, immediate nearby offshore procurement was mandatory. Nonstandard generators and air conditioners bought in Singapore and Japan later became standard headaches at installations which had little chance of getting replacement parts within six months.

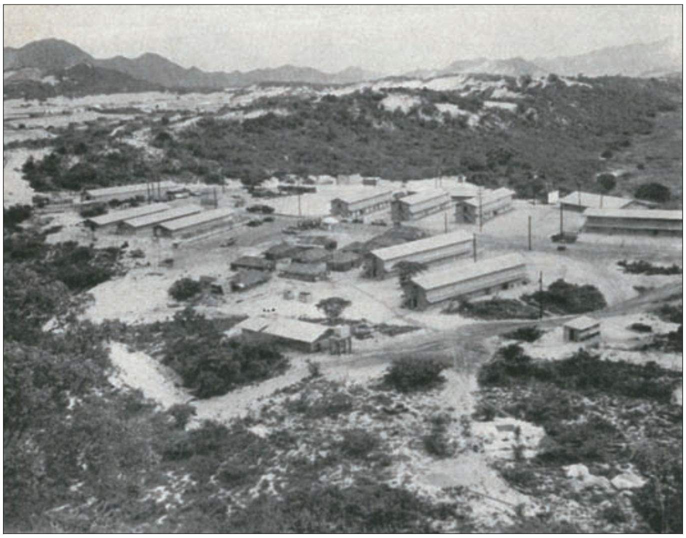
The need for nonstandard repair parts required the establishment of a special supply depot under a separate contract. This depot now supplies nonstandard parts to all American troops supported by the 1st Logistical Command, and stocks more than 18,000 line items. By a direct arrangement with supply channels in the United States, parts may be obtained within 45 days.

LABOR

Military mobilization has placed a heavy drain on the Vietnam labor pool and left little of what was, to begin with, an extremely meager source of technically skilled labor. The contractor now has 18,000 Vietnamese employees. The Army, recognizing the long range effect of the American operations on the technological development of Vietnam, emphasizes the training programs by American contractors. In October 1966, the R&U contractor established a formal department to supplement on-the-job training. The company now offers classroom instruction in more than 70 job classifications. During the past fiscal year approximately 2,000 Vietnamese attended classes, and about 3,000 were in the on-the-job training programs.

In addition to the scarcity of skilled Vietnamese labor, the





(Left) Site of the Cam Ranh Area R&U Headquarters on the Barren Peninsula, November 1966 (Right) The Same Site as Shown in March 1967 — These pictures illustrate the nature of the American build-up throughout Vietnam.

personnel level of American and third-country nationals was always behind authorized manning schedules, which, in turn, lagged behind the support needed. As an example, during 1964, the rise in the troop level from 5,000 to 14,000 increased the R&U equipment maintenance work by approximately 150 percent, but there was no concurrent increase in manning. In general, personnel resources, like materiel, have only recently reached levels commensurate with support requirements.

ENVIRONMENT

Lack of any but the most rudimentary programs of health or sanitation meant that the military bases where these services were provided had to be made into islands of health in a sea of disease and pestilence. Water sources are not safe. Malaria and plague, the latter found in all provinces of Vietnam, are serious health hazards.

Entomology services took on added importance. Since early 1967, when dead rats were found amidst equipment and cargo containers returning to the United States from Vietnam, the R&U contractor has been providing plague control service for retrograde cargo. Treatment of cargo with rat poison and diazinon insecticide dust has increased from 35 to 112 tons per month.

Entomologists found American rat poison only fairly effective in Vietnam, but the plague control program was improved when someone mixed the poison with *muoc mam*, the salty, fermented fish sauce that is a dietary staple. Vietnamese rats took to it with relish.

The contractor's entomology teams have been called upon to help stop plague epidemics in civilian communities near military bases. This work, co-ordinated between the military, the contractor, and the Agency for International Development, has halted plague outbreaks at Vung Tau. Cam Ranh, Tay Ninh, Kontum, and other smaller communities.[2]

The most critical test of civilian R&U ability in the combat zone came during the Viet Cong Tet offensive in February 1968, when the enemy struck at many installations and their support sites manned by R&U contractor personnel. The civilians kept up critical fuel and water deliveries, and maintained power plants and emergency utilities services throughout the fiercest enemy attacks of the war. Their achievements established beyond doubt the feasibility of civilian R&U support to troops in combat.

PRESENT SCOPE

The repairs and utilities operation in Vietnam has grown to the extent that today the contractor is maintaining more than 37,000,000 square feet of building area, 4,000,000 square feet of leased facilities, 115,587 acres of unsurfaced grounds, nearly 108,000,000 square feet of surfaced area, and more than 700 miles of roads. Custodial services are provided for 113,000,000 square feet of building space.

The R&U contractor operates more than:

- 2,500 refrigeration units
- 900 cold storage plants
- 1,200 air conditioning plants
- 1,000 electric generators producing approximately 23,000,000 kwh per month
- 40 ice plants, providing 10,000 tons of ice per month
- 130 water treatment facilities producing 320,000,000 gallons of potable water and 30,000,000 gallons of non-potable water a month

Services include the operation of dozens of fire stations, and the collection and disposal of 347,000 cubic yards of refuse and over 8,000,000 gallons of raw sewage a month by the sanitation crews.

R&U support is being provided at more than 100 permanent installations and at more than 230 support sites. This operation is unprecedented in size and complexity and has provided challenges which have been met successfully by the contractor's Vietnamese, third-country nationals, and American personnel who make it work.

TME

[1] Let to Pacific Architects and Engineers, Inc. (PA&E), a firm which had had prior experience in providing peacetime R&U support to the United States Army in Korea, Japan, and Okinawa.

[2] At the 1967 Western Pacific Quarantine Seminar in Manila, the Saigon representative of the World Health Organization (WHO) cited the R&U contractor's handling of these plague outbreaks. He reported that WHO was considering adopting the same procedures as a world-wide standard.

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Figure 1. Nui Sap Looking East. Project Site in foreground. Hamlet, Canal, and Existing Quarry Face, upper right.

The An Giang Quarry

By Cdr. Paul H. Bradtmiller, Civil Engineer Corps, United States Navy

While it is not the usual practice in the Naval Facilities Engineering Command, the Officer in Charge of Construction, Republic of Vietnam (OICC RVN), has engaged a single contractor to design, construct, equip, and operate a facility—in this case the An Giang Quarry at Nui Sap in the Mekong Delta. This work is for the Military Assistance Command, Vietnam (MACV).

The critical shortage of crushed aggregate throughout the Delta has posed a major obstacle to the reconstruction of the National and Interprovincial Highway System and to the Rural Construction Program. The once splendid highway system built by the French throughout the Delta has been continuously disintegrating during the war as a result of direct sabotage and demolition by the Viet Cong, the heavy demands of war traffic, and inadequate maintenance because of hostile conditions. The highways are now in a serious state of disrepair, and neither the Vietnamese Government nor Army has the equipment and personnel needed to exploit available rock resources and begin restoration work. The roads across the rice paddies of the Delta are vital to MACV, for both military operations and civic action projects.

The An Giang Quarry is now one of only four available sources of rock in the Delta; the others are military quarries at Vung Tau and Chau Doe, and a civilian quarry near Saigon. By summer (1968), the project is expected to produce at least 30 percent of the crushed rock for highway work in the Delta.

Nui Sap, which means literally "Falling Rock Mountain," is part of the series of secondary granite peaks that thrust above the rice paddies to form a chain of low hills extending southeast out of Cambodia. Nui Sap (Figure 1) is approximately 90 miles south-southwest of Saigon (Figure 2) in An Giang Province, and about 20 miles from the province seat of Long Xuyen on the canal that runs from the Bassac River to Rach Gia on the Gulf of Thailand.

The Nui Sap dome is about 100 meters high and contains some 12,000,000 to 15,000,000 cubic meters of rock reserve. This dome, the southernmost of the chain, extending above the Delta mud, consists mainly of microgranite and micaceous granite, with a certain amount of quartz, which can be identified readily in the pegmatite of the exposed west face. Centuries of erosion and weathering have left exposed and fractured excursions. From the large number of vertical faults, crossed by myriad fractures and fissures on the exposed faces, its name is highly descriptive.

For nearly one hundred years the people there have been chipping away by hand at the west face of Nui Sap. In recent years, with 4-pound sledges for the children, the elders, and the women, and 8-pound sledges for the men, the hamlet at the foot of the hill has been producing about 20 tons of crushed rock a day. The crusher at the quarry will now produce 200 tons per hour. All of the output of the plant will be MACV control for either military use or public works highway repair. The hand quarrying and crushing will continue to meet private construction needs.

ELEMENTS OF THE PROJECT

The quarry project required a topographic survey of Nui Sap for quarry planning and real estate use. To provide a suitable site for the plant, some 70,000 cubic meters of fill, rock, and overburden (which was excavated from Nui Sap), was placed on 10 acres of rice paddy. Magazines had to be constructed for storage of explosives and a haul road had to be built to the peak of the dome. Then an engineered quarry face had to be opened at the peak, and the crushing equipment erected.

Approximately 75,000 cubic meters of dredging by barge mounted clamshell was completed to extend the existing water access to the plant site. Barge loading, fuel storage, and shop facilities were constructed and seven self-propelled rock barges were built. Providing complete collateral equipment—from hand tools and jackhammers to rock-bed trucks and power shovels—was no small part of the work.

Prior to these developments, this remote area could be reached only by a two-hour boat ride from Long Xuyen or in an emergency by helicopter; hence, early in the project mobilization stage, logistic support and communications had to be established. One of the first steps was to set up a radio base station at Nui Sap to tie in with the contractor's country-wide communications network, for contact with the headquarters in Saigon and with the nearest contractor's base at Can Tho. In the rice paddies, on the opposite side of Nui Sap from the quarry, a 1,000-foot section of an old roadbed was raised and widened to provide an unpaved airstrip for small aircraft and thus give direct access to the site for management and logistics support. This was completed at negligible cost with rock and sand fill borrowed from the hamlet producers with an agreement to repay them from the test crushing runs when the plant was assembled.

The quarry and crushing plant will be operated by the contractor for at least the first year of production. This will include delivery of the crushed rock, by barge, to four critical points in the Delta: Can Tho, Cao Lanh, Long Xuyen, and Rach Gia.

A unique aspect of the project is the shipbuilding, since seven self-propelled barges are being provided in addition to the normal equipment such as conveyors, trucks, cranes, tractors, and drills. The barges are being built in a small shipyard near Saigon.

The barges are small ships, divided into compartments by watertight bulkheads. On the main deck aft of the cargo hatch there is a deckhouse for the wheelhouse and engine room access. The hull is shaped to eliminate unnecessary eddy and wave resistance, and structurally designed to permit full operation (loaded) in coastal waters with medium wave action. All structural members and fittings conform to specifications set forth by Lloyd's Register of Shipping—"Rules and Regulations for the Construction and Classification of Steel Ships." These barges are

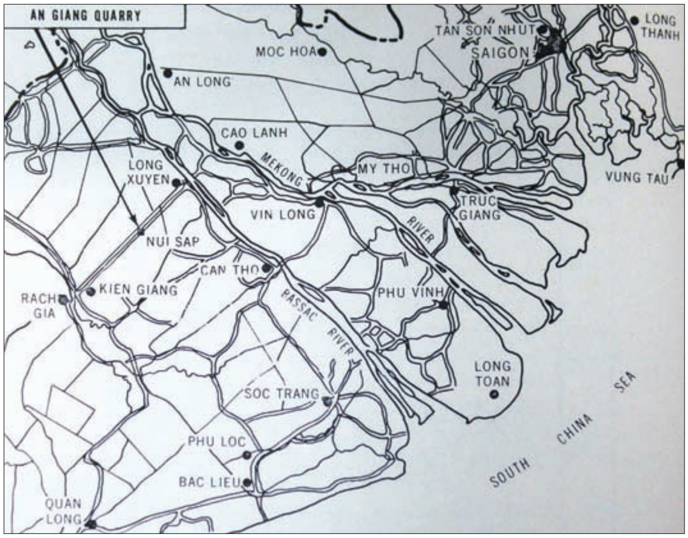


Figure 2. Site of An Giang Quarry, Mekong Delta, South Vietnam

fitted out completely with main power supply (10kw), auxiliary power supply (5kw), and ship-to-shore radio. Although the over-all management of the quarry project is under the MACV Director of Construction, it was originated and sponsored by the United States AID Mission to Vietnam to assist the Ministry of Public Works of Vietnam. Major financing for developing the quarry, establishing the crushing plant, and providing and delivering at least 17,000 cubic meters of material each month for the first year is under the AID program. Additional capital investment should not be necessary for the first ten years of operation, and the total economic life of the facility is expected to be about twenty years. It is believed that it will not only support the highway restoration in the Delta, but also will make the work economically feasible at this time.

The equipment is supplied from stocks within Vietnam and is either new or rebuilt by the contractor, The crusher, for example, was previously used at Bien Hoa for three years on the build-up of that air base. This use of rebuilt machines has resulted in financial savings to AID and made possible the maximum employment of existing construction equipment. As a by-product, this facility created for support of AID highway rebuilding programs will also be of use for military requirements in the Delta.

Acquisition of the real estate for this installation was a special aspect. Although Nui Sap itself is public land owned by the Government of Vietnam, the surrounding rice paddies are privately owned, and over the years numerous licenses have been issued by governing regimes for quarrying, farming, and settling on the slopes of the peak. To relocate the families on the site equitably, the Vietnamese Government had to reimburse the owners for their homes, graves, orchards, and rice paddies. The necessary negotiations by the province chief and the review by the government ministers in Saigon took less than three months to gain access to the site for the contractor.

Today, military engineering is having a major part in Vietnam in rebuilding the nation through the use of the An Giang Quarry in support of highway restoration and many other projects.

TME

First published in The Military Engineer, May-June 1969.

Aircraft Shelters in Vietnam

By Capt. Paul Y. Thompson, United States Air Force Civil Engineering

Of highest priority in Vietnam during 1968 was the construction of protective cover for tactical aircraft at the various military bases. Known as the Hardened Shelter Program, this construction was approximately 30 percent complete by the end of 1968 and is continuing as a major project in 1969. The task of erecting the structures was assigned to RED HORSE Squadrons[1] and constitutes their largest single project.

The shelters are 72-foot-long, 48-foot-wide, and 24-foot-high corrugated steel arch structures which are covered with concrete for protection against rocket and mortar fire. The arches are made of 10-gauge galvanized steel with dimensions to fit into the 52-foot-wide steel revetments, built by Air Force troops in 1966 and 1967. The shelters are placed in 8-gauge channel base plates which are bolted to the concrete ramp. Each shelter is composed of 324 panels (with a total weight of 31 tons) bolted together into 36 rings with 15,141 bolts.

The erection process includes installation of base plates, pre-assembly of 3-ring sections on the ground, raising the sections, securing the sections together, and tightening bolts with torque wrenches.

At Bien Hoa Air Base the 823rd Civil Engineering Squadron (CES) RED HORSE, began erection of the shelters on October 1, 1968. The project necessitated a 24-hour day, 7-day work week, with a force of some 100 workers. As the process of erecting the steel was mastered and improved, the unit was assigned to place a concrete cover on the first shelter. Thus, the first operational hardened shelter in Southeast Asia was completed on November 4, 1968.

(Top) Figure 1. Placing Concrete from Pump Truck with Boom and Tube
(Left) Figure 2. Completed Shelter Housing F-100 Jet Aircraft (Jet Blast Deflector in Rear)

PROCEDURE

The key operation in the process at Bien Hoa was the pre-assembly which required about 2 assemblers to 1 erector to keep ahead of the erection crews. There was not enough ramp space for the pre-assembly and erection work to be conducted simultaneously, so the pre-assembly crews worked at night. Temperatures were cooler at night, increasing the efficiency of the crews, each of which assembled an average of nine 3-ring sections a night (equal to ¾ of a shelter). Bolts were hand tightened and lifting lugs were attached. The assembly force was divided into 6-man teams, each working on a 3-ring section.

Two erection crews were formed to raise and secure the sections and tighten bolts. One 20-ton crane with a 50-foot boom was used for the lifting. Each team used the crane for half a day and spent the other half day securing sections and tightening bolts. This sequence resulted in the most efficient use of the crews and crane.

Installation of base plates was a routine task which took a 3-man crew less than eight hours to drill holes, grout-in the anchor bolts, and fasten the base plates. The bolts were set into the ramp 9 inches apart, and were not tightened until after the shelter was set up. This gave some flexibility in placing the sections.

Fastening the sections together was the most difficult step in the construction. The procedure was to align the overlap weather edge at the lap joint with drift pins as the section was lowered into place; bolt the section to the base plate; and then place and tighten all bolts, starting at the top and working simultaneously on either side toward the bottom. Any misaligned holes were corrected with drift pins.

In the capping operation the first step was to install metal slip forming, which was supplied with the shelter components. Concrete was placed in a 2-foot lift first on one side, then on the other, alternating progressively from side to side with 4-foot lifts to assure no more than a 2-foot differential. This process was used to obtain symmetrical loading of the structure to avoid the creation of excessive shear stresses and deflections.

A concrete pump truck (Figure 1) was used to provide the mobility required to place concrete on alternate sides with horizontal runs of 72 feet. Although this equipment can pump up to 60 yards of concrete per hour, this volume was not reached in this operation.

During the early pumping, a separation of the aggregate and sand caused the pump to malfunction. After experimenting with several mix proportions, a mix with a 1 to 1 sand-aggregate ratio (¾-inch aggregate maximum), a 6 to 1 water-cement ratio, and a 4-inch slump was used. This concrete mix was pumped without difficulty. It was necessary to vibrate the concrete to obtain accurate placement. (The mix had a 4-inch slump because of the pumping operation; if a crane and bucket were used to place the concrete, a mix with a lower slump would be satisfactory.) Compressive strength attained by the concrete was from 3,100 psi to 3,500 psi. A total of 500 cubic yards of concrete was required.

A transit was used and control points established to measure the deflections of the shelter (both horizontal and vertical) as the concrete placement progressed. Continuous readings were taken during the capping operation to study the loading effect on the metal structures. No deflections were detected. This information will be valuable in further detailed study of this particular aircraft shelter to determine whether lift heights may be increased to expedite construction in combat zones.

From a review conducted after the capping of the first shelter, it was decided to cap two shelters simultaneously. With experience, the capping operation time was reduced to 1,600 man-hours per shelter as compared to 2,400 man-hours for the first shelter.

RESULTS

Because of weight on the footings (6.5 kips/ft^2/ft), joints were sawed 13 inches inside of each base plate to isolate the footings and to prevent propagation of cracks through the ramp in case of settlement. After three months, no cracks had appeared in the concrete on the shelter and no ramp settlement had occurred. The completed shelter is shown in Figure 2.

From the experience and results of this program, valuable information has been obtained on shelter construction and concrete techniques, and the Air Force RED HORSE Units have demonstrated their function as a deployable team for a critical mission.

TME

[1] Air Force Civil Engineering RED HORSE (Rapid Engineer Deployment Heavy Operational Repair Squadrons Engineering) units.

First published in The Military Engineer, July-August 1969.

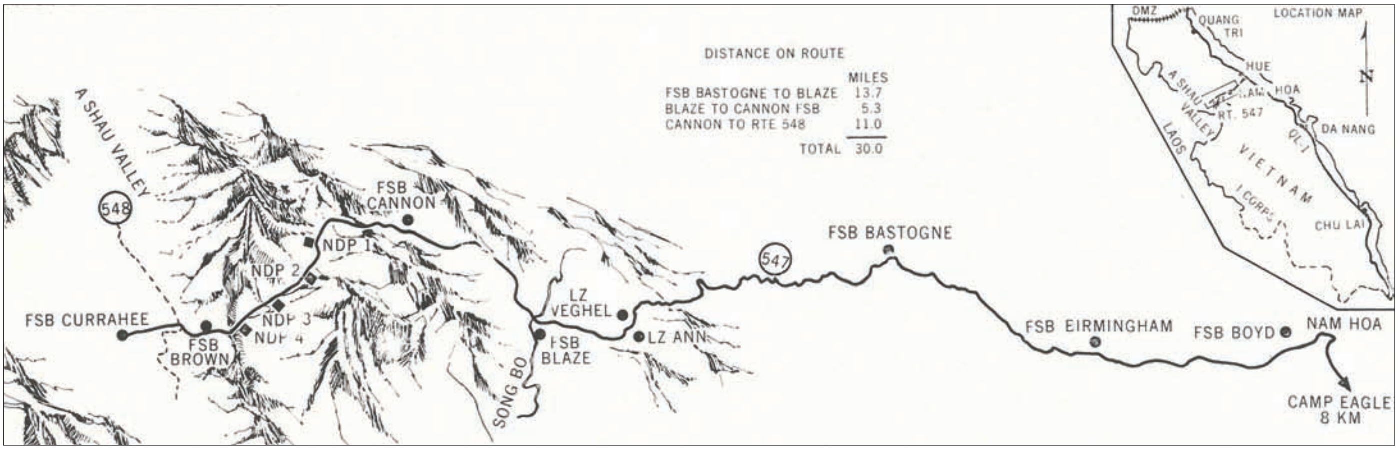


Figure 1. Pioneer Route to the A Shau Valley

OPERATION "HORACE GREELEY": Expressway to the A Shau Valley

By Lt. Col. Malcolm. D. Johnson and 1st Lt. Richard B. Fisk, Corps of Engineers, United States Army

When regular troops of North Vietnam infiltrated into I Corps Tactical Zone of South Vietnam in large numbers in early 1968, they used the A Shau Valley as a principal access route (Figure 1). Long controlled by the North Vietnamese Army, the A Shau Valley is in a remote region where unpredictable weather and densely forested surrounding mountains had severely hampered Army and Marine operations aimed at cutting this primary enemy infiltration route. The many North Vietnamese troops and great amounts of materiel moving through the valley posed a constant threat eastward toward the imperial city of Hue and southeastward toward Da Nang, the second largest city in Vietnam.

In May 1968, the 27th Engineer Combat Battalion, reinforced with the 591st Engineer Company (Light Equipment), based at Gia Le Combat Base near Hue, constructed a new road from Camp Eagle to the village of Nam Hoa and began the upgrading of Route 547 from Nam Hoa to Fire Support Base (FSB) Bastogne, a distance of 15.5 miles. Previously established as a seasonal fire support base by the 101st Airborne Division, FSB Bastogne depended entirely upon helicopters for supply. The existing Vietnamese trail, Route 547, was unsuitable for military traffic. Using assigned equipment, including a provisional landclearing team of ten tractors equipped with Rome plows, the engineers succeeded in opening the road to Bastogne with some 200 yards cleared on each side of the roadway by July. For the first time, 175mm self-propelled guns were placed within range of the A Shau and were able, in early August, to support the 101st Airborne Division operation into the valley, Operation Somerset Plain. The 27th Battalion then continued to develop the fire base and upgrade the road for all-weather use.

PLANNING

The XXIV Corps plan for movement into the A Shau Valley was announced in January 1969 and called for an all-weather road as an extension of the pacification program. The 45th Engineer Group began extensive planning and reconnaissance to determine the feasibility of extending Route 547 westward from FSB Bastogne to the A Shau Valley. In spite of the extremely rough terrain along the entire route, the condition of the trail (which was little more than an overgrown footpath), and the weather, it was estimated that a pioneer road could be pushed into the valley within 90 days and could be upgraded to all-weather standards within 180 days. The 45th Engineer Group was assigned to construct the road.[1] Construction was to begin as soon as the existing operational requirements would permit the use of adequate engineer and security forces. The 27th Engineer Combat Battalion reinforced with the 591st Light Equipment Company was assigned to extend Route 547 westward, in a project termed Operation Horace Greeley (Figure 1). In February, while additional upgrading work was conducted on the road between Camp Eagle and FSB Bastogne, preparations for Operation Horace Greeley were underway. A 75-ton-per-hour rock crusher plant was moved to FSB Birmingham for the road work to the west, and one combat engineer company was moved to FSB Bastogne in mid-March to begin the development of an engineer forward base camp. In addition, the newly formed 59th Engineer Company (Land Clearing) was ordered to terminate its clearing operation near the DMZ and prepare to join the A Shau project.

PIONEERING

Operation Horace Greeley was officially launched on March 20 with a land-clearing platoon of the 59th Engineers and the 27th Battalion beginning pioneering operations westward. The rest of the 59th Engineer Company joined in the clearing work on March 22, and also provided D7E tractors equipped with bull blades to help in a first priority project to push a pioneer road to the Song Bo River. The road reached FSB Veghel on April 1 after rising and descending over 780 feet in elevation. At this point, the forward units left the original trace of Route 547 to reach the Song Bo River at the site of a proposed fire base, FSB Blaze. Again climbing a hill mass over 650 feet high, the battalion reached the Song Bo on April 9 and began construction of the new fire base. The 59th Company continued clearing operations along the 14-mile pioneer road, working out of a night defensive position established between Bastogne and Veghel. By this time other units including the 630th Light Equipment Company and the 511th Panel Bridge Company had reached Bastogne and were working on upgrading the pioneer road. Extensive demolition work was begun to widen the narrow passes and sidehill cuts to two lanes. Three timber trestle bridges were constructed to replace fords, and numerous culverts and headwalls were installed.

By April 17, the forward unit was established at FSB Blaze. Extensive development of the fire support base was then begun in preparation for additional tactical units, and pioneering operations were started west of the Song Bo. An 8-inch self-propelled gun battery was moved from Camp Eagle to FSB Blaze. Major road work was continued east of Blaze as additional units were committed to each section of the road. On April 26, after a maintenance stand-down period, the 59th Company resumed clearing operations east and west of Blaze. Throughout these operations, 175mm guns had remained at FSB Bastogne within range of the A Shau Valley, but the more accurate 8-inch guns at Blaze were not within range to support the tactical operations in the northern part of the valley. As progress on the road west of Blaze was slowed by demolition work and the clearing of a mine field, an alternate temporary route was quickly pushed through to establish FSB Cannon, a night-defensive position 5 miles west of FSB Blaze. FSB Cannon was within 8-inch gun range of the northern A Shau. On May 3, FSB Cannon was occupied by a battery of 8-inch guns, and construction on the main alignment of the road continued. Along this section, Rome plows of the 59th Company uncovered three Russian 85mm artillery pieces which had apparently been buried by the North Vietnamese Army a year earlier. These guns, all in excellent condition, were the first weapons of their size to be captured by engineers in Vietnam.

As forward units of the battalion reached FSB Cannon and prepared for the final pioneering advance into the A Shau Valley,

(From Top to Bottom) Pioneer Road between FSB Bastogne and FSB Veghel; Upgraded Section of Route 547 from Camp Eagle; Upgrading Operations near LZ Ann

(From Top to Bottom) Route 547 below FSB Veghel; The Route at NDP #2; Clearing Unit Moving in Cut near A Shau Valley

Rising from an elevation of 300 feet at FSB Cannon to an elevation of over 2,100 feet before entering the valley, the existing road between Cannon and the A Shau was little more than a foot trail.

additional units began upgrading operations between Cannon and Bastogne. Task Force Tiger was now composed of over eleven engineer companies, including one company of the 1st Vietnamese Army Engineer Battalion. As the road to Blaze had been sufficiently improved for daily convoy movement, 175mm guns were moved up, and a helicopter refuel and rearm base and engineer equipment maintenance facilities were established at this point.

The 27th Battalion then began construction of the most difficult section of Route 547. Rising from an elevation of 300 feet at FSB Cannon to an elevation of over 2,100 feet before entering the valley, the existing road between Cannon and the A Shau was little more than a foot trail. The first night-defensive position (NDP) was established 4 miles west of Cannon on May 26. NDP 2 was established 2 miles farther west on May 30, and NDP's 3 and 4 were reached by June 11. As the engineers began to push the last 4 miles into the valley, upgrading operations were begun to the west of Cannon. On the morning of June 13, the First Platoon of Company A, 27th Engineer Battalion, supported by four tractors of the 59th Company, topped the eastern rim of hills surrounding the A Shau, and by noon this engineer force, secured by an infantry company, reached the intersection of Route 547 with Route 548 on the valley floor. Some of the engineers moved through tall elephant grass across the valley to FSB Currahee, while a new fire support base, FSB Brown, was established on the rim of the valley for an engineer base.

COMPLETION

In 86 days, the engineers of Task Force Tiger had moved over 600,000 cubic yards of earth and had installed over 12,000 linear feet of culverts in the construction of 30 miles of road, while the 59th Engineer Company had cleared over 3,800 acres of extremely difficult and precipitous terrain. By mid-June, the road had been improved sufficiently to allow armored personnel carriers and vehicles to enter the valley.

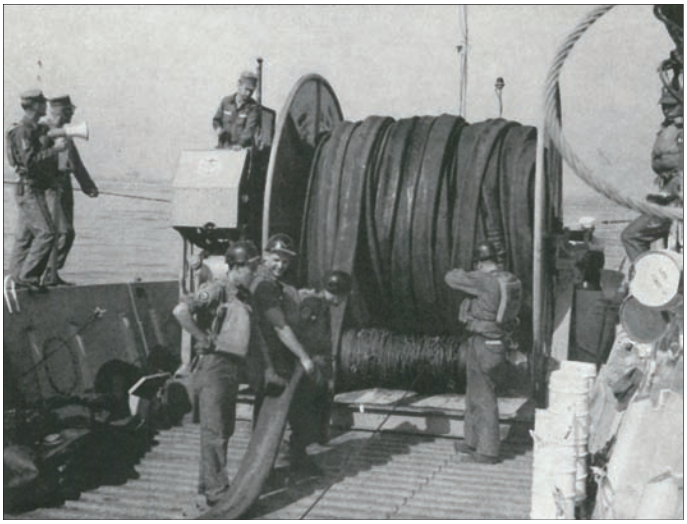
Culvert installation and road widening operations were continued between NDP's 1 and 4 to provide for passage of M48 tanks, and site preparation for a new 75-ton-per-hour crusher plant was begun at FSB Cannon. Major upgrading work was continued to make the road suitable for all-weather use and FSB Blaze was developed into a forward supply area for the 101st Airborne Division. With armored vehicles able to operate in the valley, the 59th Engineer Company moved to the edge of the valley to support the Division action.

Operation Horace Greeley, a most audacious combat engineer operation, was another striking example of the ability of the combat engineers to overcome severe obstacles posed by terrain, weather, and the enemy to fulfill their part in the combined arms team.

TME

[1] By Headquarters, III Marine Amphibious Force, the senior United States headquarters in I Corps Tactical Zone.

First published in The Military Engineer, March-April 1970.



(Left) Ready to Attach Hose to Tension Relief Cable as Both are Wound Off the Reels in Launching (Right) Attaching a Floater Buoy to Hose at 50-foot Interval as the Hose and Cable Are Payed Out

Ship-to-Shore Bulk Fuel Systems

By M. H. Falkenstine, J. J. Traffalis, and Lt. j.g. P. T. Bradley, Civil Engineer Corps, United States Navy

To an observer, an amphibious assault in Vietnam would, at first, look very much like those in previous wars. But the large influx of vehicles and equipment onto the beach would quickly indicate a difference, particularly when fueling operations were begun. For within a few hours of the initial assault, Navy Seabees now install either a buoyant hose or a bottom-laid pipeline from the beach to a tanker, perhaps a mile offshore, for bulk delivery of fuel to Marine Corps depot facilities ashore. A striking contrast to the era of the 55-gallon drum!

The great numbers of machines and the fast-moving pace of modern warfare make efficient, high-volume fuel delivery a major requirement. The sophisticated vehicles and equipment need fuels rapidly in great quantity for successful operations in assault areas where port facilities are lacking.

The first attempt to improve on the oil-drum method was a Marine Corps system to transport fuel from ship to shore in 900-gallon collapsible rubber tanks. While this was an improvement over the previous system, it still was too slow. After reaching shore, the fuel had to be transferred across the beach to the storage tanks and this took too much time. It was difficult to operate the ferrying vehicles in heavy seas and there was the problem of their fuel consumption and maintenance.

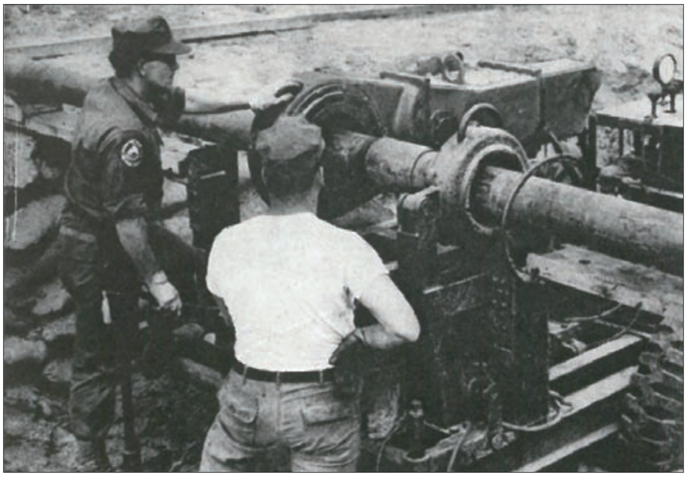
Both systems have been used extensively in Vietnam. At Cau Viet, a bottom-laid fuel system installed in February 1968 is still in use and supports the Allied troops in the vicinity of the DMZ. Another one in operation is a bottom-laid system installed at Da Nang in October 1967.

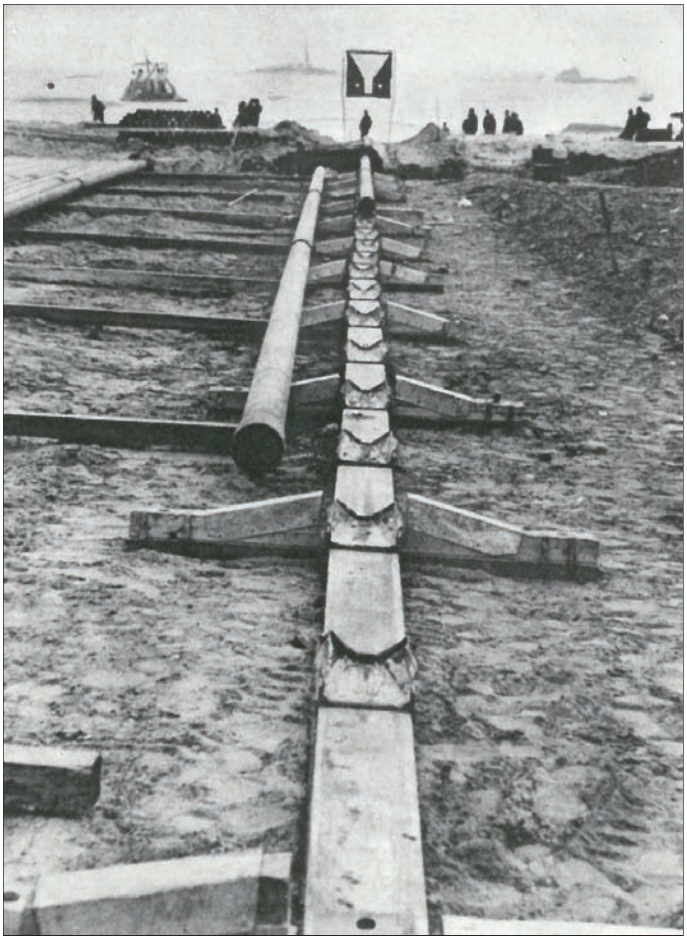
The next system developed consisted of 5,000 feet of 4-inch hose in 250-foot lengths, a tension relief cable, lightweight anchors, and floating hoses, all deployed from an LCM (Landing Craft, Mechanized). This technique was superior to previous ones but its deployment from LCM's was hazardous except in calm seas and the floating hose was extremely vulnerable to damage from surface craft and enemy action.

Subsequently, for improved fuel delivery, a specific task was undertaken[1] to develop a hose or pipeline system with a high delivery capacity, which could be installed early and quickly in amphibious operations, and which would not have the disadvantages of previous systems.

The two delivery systems developed are the buoyant hose and the bottom-laid pipeline. A 4-inch line was first provided in both systems but it was soon apparent that the capacity of this line would be insufficient to meet fuel needs. Consequently, a 6-inch hose and pipeline were adopted as standard. Other criteria common to the buoyant and bottom-laid systems were a flexible connection on the seaward end to be joined to an AOG (Auxiliary Oiler, Gasoline), a suitable anchorage for the AOG tanker, equipment to fit Marine Corps receptacles ashore, submergence of lines (to avoid interference with surface craft), and a method of rapid recovery.

The buoyant fuel system is a collapsible hose payed out from a power reel mounted on an LCU (Landing Craft, Utility) or a warping tug. A supporting steel cable to relieve tension on the hose is attached to it near each hose connection at 50-foot intervals. Inflatable floating drums of rubberized fabric, also attached to the hose every 50 feet, suspend it in the water at a depth of 5 feet.





(Clockwise from Top Left) Inspecting Joint as Pipe is Put Together; Storage Area and Launching Ways in Beach Layout; Pushing 90-foot Section of Pipe to Storage Area

To provide resistance to lateral currents, 100-pound anchors are attached to the cable at 200-foot intervals. The 6-inch hose has a capacity of 380 gpm of diesel fuel or 590 gpm of AVGAS at 15 psi at the shore end. A trained 18-member crew can install this 5,000-foot system in six hours.

The bottom-laid system consists of a 5,000-foot pipeline made up of 30-foot lengths of buttress-threaded oil-field casing screwed together with power tongs. A prepared beach site is required for three trailers of pipe to be assembled and launched. The assembled pipeline is pulled seaward by a warping tug. This system can be installed and ready for use in about 16 hours. A crew of 29 members ashore and 12 on the tug is required to set up the site, assemble the pipe, and install the system in the sea.

A properly prepared beach site is essential to a successful pipe installation because the straight alignment of the ways (or platforms) which guide the pipe to sea and precise positioning of the power tongs are vital to the operation.

The components of the system most difficult to maintain in operation are the tanker mooring and the riser hose at the seaward end which connects with the tanker. The riser hose is subject to leaks from twisting and kinking and to being cut or damaged during ship mooring. Much of this trouble is caused by attempting to moor the tanker during sea conditions which exceed design limitations. This frequently happens in Southeast Asia where there are extended periods of high seas and operations must continue under wartime urgency.

Both systems have been used extensively in Vietnam. At Cau Viet, a bottom-laid fuel system installed in February 1968 is still in use and supports the Allied troops in the vicinity of the DMZ. Another one in operation is a bottom-laid system installed at Da Nang in October 1967. Previously, fuel was supplied to the Marines at Da Nang by a buoyant system.

Expedient variations of these methods have to be used under some conditions. For instance, during the monsoon season even seagoing tankers cannot navigate the mouth of the Cau Viet River, 85 miles north of Da Nang. To meet this situation, LCM-8 cargo boats with 10,000-gallon rubber bladders are frequently used to transport fuel from the tankers to the beach.

The Seabees are attempting to improve existing systems based on operational experience and to develop a new fuel system barge which will require a crew of 12 instead of the 18-member crew needed for the buoyant system. Other research is being conducted on small mono-moorings[2] to handle 6- to 12-inch lines, extensions beyond the existing 5,000-foot length and 50-foot depth of the installation, and facilities for fueling harbor craft. Through this Research and Development Program, the Navy is achieving improved technical efficiency in supporting operations, and is saving lives as well as dollars.

TME

[1] By the Naval Facilities Engineering Command (NAVFAC, at that time called BUDOCKS) and Naval Civil Engineering Laboratory.

[2] Combination oiler anchorage and hose terminal

First published in The Military Engineer, July-August 1970.

LAND CLEARING in the Delta, Vietnam

By Capt. Stephen E. Draper, Corps of Engineers, United States Army

Land clearing is now an integral part of military operations in the Mekong Delta, Vietnam, but this was not always so. The use of Rome plows in the central part of the area, with its inundated rice paddies and poor drainage, was considered infeasible by most engineers until the first part of 1969, when a joint American and Vietnamese Army (ARVN) engineer operation changed that view.

Prior to the operation, the area between Sa Dec, Vinh Long, and Can Tho was under Viet Cong (VC) control, except for the parts adjacent to Highway 4, and became known as the VC "Y" base area because of its canal network. It served as a VC supply center, rest area, and jumping-off point for attacks on all three towns. Stationed in the towns were IV Corps Headquarters, an American Army airfield, and the 9th ARVN Infantry Division Headquarters.

The VC had dominated this section of the Delta since 1954, and had the advantage of cover and concealment in the vegetation around the canals. Removing this vegetation was the most desirable way to destroy the enemy sanctuary, but the area was too large for hand-clearing. The use of Rome plows had been ruled out by the poor trafficability of the terrain. In the Y, rice paddies cover approximately 80 percent of the land, the rest being cultivated woodlines. Four main canals form the Y, and there are many others interspersed throughout the area. Together they provide the major means of local transportation. The alluvial soil next to the canals, on which most of the woodlines exist, is poorly drained, clayey material with organic matter in the topsoil.

Since all attempts to gain permanent control of the Y area had failed, it was decided in early 1969 to try the Rome plow technique. Consequently, an extensive operation was planned with a combined task force of American and Vietnamese engineers to destroy as much enemy cover and concealment as possible. The Americans provided the plows and the Vietnamese engineers provided all other support, with over-all control by the Division Engineer Advisor. The operation was scheduled to begin one month after the end of the rainy season.

THE OPERATION

The 15th ARVN Infantry Regiment, reinforced by Armored Cavalry elements, was sent in on January 15 to clear out the two enemy main-force battalions and the provincial company in the area. At the end of the month, with this operation completed, the 15th Regiment left a battalion as security; the Vietnamese 9th Engineer Battalion moved in by land, and the American 595th Engineer Company arrived by water in LCM-8's. Three plows were used at the start and, working along the edges of the canal, some 684 acres were cut in 37 days. The canal was thus cleared, on both sides, for 8 kilometers, providing sufficient observation to deny the VC the use of that section of the canal.

With such excellent results, the operation was continued and, in 75 days, 1,833 more acres were cleared, linking the northern secure areas with those in the south. This provided an effective barrier to VC movement and, in addition, uncovered a vast amount of intelligence material. As a step in pacification, 50 square miles were cleared of all traces of VC activity, providing a base for extensive road construction and making it possible to bring in labor forces and friendly civilians. Technically, the operation proved that Rome plows and other heavy equipment could be used effectively in delta-type terrain.

> Penetration by the plows of a particularly wet area may be impossible at first, but repeated attempts to negotiate the terrain with heavy equipment will disturb the soil enough so that, after a day or two, it will dry out sufficiently for effective work.

A total of 2,077 bunkers were destroyed along with 56 living areas, and quantities of ammunition, equipment, and documents were captured. A 10-bed hospital was discovered and subsequently destroyed. During the operation almost 50 percent of the small American contingent were wounded and half of the dozers disabled by mines.

TECHNIQUES

Many new techniques were innovated. The general procedure includes intensive advance aerial and ground reconnaissance, the construction of an access road parallel to the main canal, and clearing of 30 to 50 meters of underbrush from the canal. A conventional blade D7E bulldozer is used to construct the road

Rome Plow Operating in the Delta with APC for Security in the Background

which is extended far enough to cover a day's work and no farther. From this road, perpendicular branches are extended out to the paddyland to provide access for the Rome plows.

Normally, the tree cutting is left to the Rome plows and the bulldozers are used to build the access routes. Not all woodline can be cut, and it is up to the supervisor to decide at what point cutting is no longer efficient. Wood that is left standing can be removed by chain and hand saws.

Ten specific techniques were developed.

(1) Canals over 10 meters wide and 2 meters deep are obstacles which are not efficiently crossed by filling in. The M4T6 raft and the LCM-8 are excellent means for crossing, but if such equipment is not available or does not suit the canal system, an earth dam must be built.

The M4T6 raft is the most efficient system, and the equipment may be kept with the work force since base camps are near the canal and can provide night security to the raft. If a four-ponton raft must be used, only one plow may be crossed at a time. A five-ponton raft is much better because an APC can be transported with the plow, adding to security on the far bank. The winch on the plow may be used to pull the raft across, and is more efficient than tow boats. Tidal action must be gauged to prevent grounding delays caused by low tides. The major disadvantage of the raft is the time required to dismantle it, transport it to a new site, and reconstruct it. It took the ARVN engineers five days to do this on a move of 23 kilometers.

If the canal is large enough and access is available, LCM-8's may be used to cross. Ramps must be built and crossing at low tide is normally prohibited. It is advisable to load only one plow per LCM-8, as the weight of two machines lowers the front end of the vessel in the water and causes unloading problems.

When an earth dam is required, construction is costly in time. The site of the dam must be selected bearing in mind the availability of fill material, a major problem in the Delta. The dam, of course, will stop the flow of water and can cause the stream to overflow around the dam into the work areas.

(2) Any canal can be crossed by filling, but if it is narrow enough (1-3 meters) and the banks are firm, the Rome plow can "jump" it without filling. The blade, weighing 5 tons and projecting forward 2 meters, provides a counterbalance which makes the "iump" possible. The operator approaches the edge of the canal and pushes his blade down on the far bank. He then moves forward over the canal, supported in the rear by the back part of the track and in the front by the blade, which, because of its horizontal cutting edge, will not bite into the soil. As the rear tracks leave the rear bank, the weight of the blade and the forward motion pull the dozer across. It is essential that the banks be firm; otherwise, support will be lost and the dozer will sink into the canal. The jump technique is fast, and by its use parallel narrow berms can be cleared as the plows work perpendicular to the berms.

(3) The winch on the D7E bulldozer is a most important device for work in the Delta, where equipment invariably gets stuck in wet areas. With the winch, any dozer can be extracted by one or more others, but a sharp eye must be kept on the work to insure that all equipment is not stuck at the same time. A dozer can extract itself with its own winch if a suitable anchor can be found. Three APC's in column normally will work as an anchor; deadmen will not because of the low bearing pressure of wet soil, and trees are usually too shallow-rooted to be useful. A D4 dozer can be used by placing it with the blade toward the stuck equipment and running the winch cable over the blade and hooking it onto the belly nan; thus, the winch cable will force the blade into the ground, making a stable anchor.

(4) Penetration by the plows of a particularly wet area may be impossible at first, but repeated attempts to negotiate the terrain with heavy equipment will disturb the soil enough so that, after a day or two, it will dry out sufficiently for effective work.

(5) Mines and booby traps constitute the greatest hazard to operators, and safety precautions are mandatory for such an area to be cleared. Almost all booby traps in a woodline are set for personnel, and when they are detonated by the dozer blade no damage occurs to either the equipment or the operator. But it is essential to keep plows 30 to 40 meters apart to prevent mine fragments from hitting operators of adjacent dozers.

Large mines are most dangerous because they will damage equipment and, although shrapnel cannot hit the operator, he may suffer injury by being thrown around in the cab. If mining is suspected, the operator can be protected by flak vests and aircraft helmets. Seat belts would provide further safety. An area known to be mined for equipment should be cleared by hand or the mines destroyed in place.

(6) Knowledge of the terrain is vital to land clearing in the Delta. Prior to entering an area, aerial photographs with a scale of 1:2,500 or larger should be obtained, and reconnaissance should be made by helicopter. During operations, daily visual reconnaissance by helicopter is essential to determine the current situation and methods of future work. Additional on-site, foot reconnaissance is required to find the most efficient access routes.

(7) A large, 25-pound-per-link chain can be used with bulldozers to clear inaccessible areas. Dozers traveling to the paddy on straight access roads from the canal, 30 to 40 meters apart, may drag a 50- to 60-meter chain between them to clear the area. This operation must be closely co-ordinated and takes highly experienced operators. Large trees cannot be cleared by this method, and must be destroyed by demolitions before using the chain.

(8) Bulldozing is the most effective means of bunker destruction. It is essential for the dozer to fill the entire bunker and not just remove the overhead cover, leaving the hole intact.

(9) Removal of the residue following clearing operations is always a problem. While civilian woodcutters constitute a security risk, they are excellent workers for residue removal, and they completely clean out felled trees.

(10) Usually, rice paddies are impassable to Rome plows, but whenever the paddies are dry, woodlines may be worked from the paddy side, greatly facilitating their total destruction.

SUMMARY

A key factor in plow operations in the Delta was experience. Knowledge of the equipment and its capabilities is of greatest importance and is acquired only through extensive training of operators and supervisors.

One point worthy of special thought is that the Vietnamese hold land particularly dear, and the clearing of the woodline destroys part of their livelihood. Psychological efforts should be made with all such onerations to gain the understanding of the local population to prevent hostility of the civilians and attendant problems for the engineers.

A further obstacle is the Vietnamese custom of burying their dead in the high ground of the Delta. This means that graves are placed in the woodlines and often form barriers to plow operations. Graves cannot be destroyed and must be left intact even at the expense of having an area remain uncut.

The Delta clearing operation was a success in spite of the problems caused by the joint organization, the newness of the idea, and the terrain difficulties. The technique evolved was a major factor in starting the pacification of the long-held Viet Cong base area and in bringing about the dispersion of two enemy main-force battalions and several companies.

The idea of using the Rome plow in the Delta provides three benefits in pacifying an area: it robs the VC of most of their cover and opens their lines of communications to aerial observation; it gives a psychological advantage to ARVN forces by destroying booby-trapped tree lines; and it provides a force that operates in a given area for a long time, thus insuring the continued dispersion of the enemy and demonstrating to the people that their government forces can hold control of an area.

TME

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Long Bridge at Bong Son

By Capt. Roger L. Baldwin, Corps of Engineers, United States Army

Situated some 50 miles north of Qui Nhon on Highway QL-1 is the rural Vietnamese town of Bong Son. South of the town, the Song Lai Giang River flows easterly intersecting QL-1 and continues on to the South China Sea. The river is approximately 1,600 feet wide and reaches depths in excess of 15 feet during the monsoon season. Two bridges (a refurbished railroad bridge and an Eiffel bridge) provided the highway crossing. By December 1969, traffic had become congested, as QL-1 was used as a main supply route for Landing Zone English and other military installations to the north, and a dual-lane permanent bridge was needed.

The bridge, 1,634 feet long with a roadway 24 feet wide, was to comprise twenty-six 60-foot steel spans and one 70-foot span. This was the longest bridge to be built by American troops in Vietnam. Each of the 26 piers consisted of a reinforced concrete cap resting atop ten H-piles driven to a resistance of 115 kips each. Each abutment was 18 feet high and contained 230 cubic yards of reinforced concrete. The stringers, with diaphragms installed, were decked with 8-inch reinforced concrete slabs surfaced with 3 inches of asphaltic concrete. Handrails, curbs, lighting, and a pier protection system were to be installed after decking was completed.

After the building of the Bong Son Bridge was assigned to the 84th Engineer Battalion, the construction progressed through the customary planning, mobilization, and production stages.

PRELIMINARY WORK

In planning the task organization and scheduling material and equipment requirements, it became obvious that the project would require more than a single construction company because of a shortage of critical skills such as welders and crane operators. The construction company was therefore augmented with a port construction detachment. A CPM analysis, in addition to showing up the crane and welding operator deficiencies, provided the basis for early recognition of critical steel requirements and afforded long lead times for the requisitioning of these materials.

Planning for the development of an efficient industrial site posed a host of problems, mainly the necessity to mobilize the work in a sea of mud and be ready to go into full production as soon as the area dried out. Those areas which would dry out first were developed into production facilities for components which would take the longest time to produce.

Mobilization of the industrial site began with the development of the camp perimeter and cantonment facilities. At the same time, personnel were trained in the operation of 40-ton cranes, welding machines, transit mixers, and other special items of equipment. A means of diverting the river was needed so that a construction causeway could be built. The method selected was to construct a simple cofferdam by dozing sand from the river bottom into a dike extending above the water surface to divert the flow to the far shore. Making closure of the last 15 feet of the dike to an existing causeway was particularly difficult. The water washed the sand away almost as fast as it was dozed up from the bottom. This action was finally overcome by putting all five available dozers on the job at once. The flow of water was stopped across the river to within 250 feet of the far shore, and the causeway was widened to 80 feet. At the appropriate time during pile driving, the river was diverted through a near-shore cut in the causeway to allow extension of it to the far shore.

The precast deck slab yard was made big enough to accommodate the interior and exterior deck slabs for a complete span of the bridge. Construction of this facility was necessarily slow because of the precise form dimensions required. The time taken in this operation was more than justified when the deck slabs were placed on the bridge with relatively few problems.

Fabrication of the rebar processing yard proceeded with the construction of rebar forms and a bending table. The forms were no problem but the configuration of the bending table went through a number of trial and error changes to ease the task of bending all rebar by hand. After trying jigs of various dowel arrangements without success, a lever with a roller attached to the short end was fixed to the table top so that when the lever was turned, rebar was forced to bend while being held between a retaining dowel and the roller. This was a successful improvement over the first arrangement and was considerably less tiring to the workers.

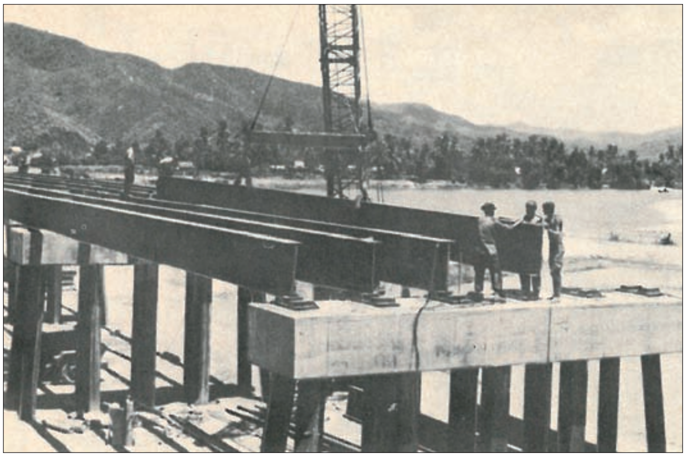
The stringer yard was originally laid out utilizing a table made from five steel beams resting on edge and parallel to each other on 10-foot centers. The beams were shimmed with wooden blocks to level the upper flanges with each other to provide a flat table. This did not work since the loads caused differential settlement of the beams and resulted in crooked stringers. This was remedied by releveling the table and encasing the bottom flanges in concrete to eliminate settlement.

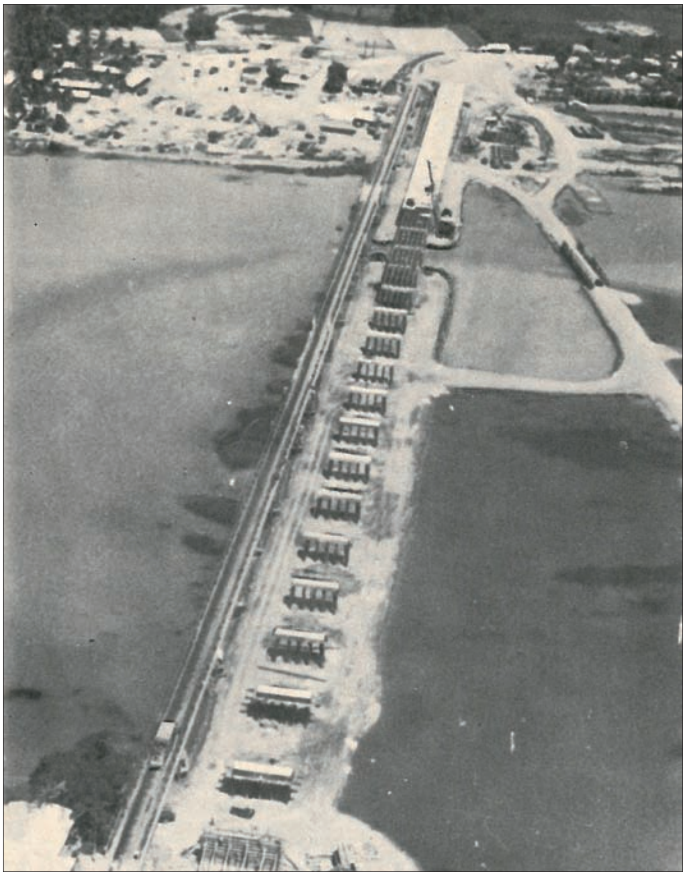
CONSTRUCTION OPERATIONS

The first pile was driven on January 22, 1970. Two 40-ton crane pile-driving rigs, each equipped with a 7,500-foot-pound diesel-driven hammer, were used on the construction. The procedure was to drive an initial 40-foot length of pile, splice the next section to the driven section, and resume driving. Final lengths averaged 75 feet. The two main problems in these operations were the difficulty of maintaining accurate position of the pile during driving, and the time-consuming task of making splices. For accurate positions, templates were made of 12-inch channel iron which could be easily knocked apart and away from a driven pile. The templates could be reassembled and surveyed into position for succeeding piers. It took the welders about two hours to splice a pile while it took only about 30 minutes to drive one. With the welders working day and night, the resulting balance worked nicely, and the maximum number of piles driven in one day was twenty-one.

Construction of the abutments took approximately four weeks

(Left) Setting Stringers on Completed Piers
(Right) Aerial View of Bong Son Bridge Under Construction





apiece. They were built in six separate components—abutment footer, two wing-wall footers, abutment, and two wing walls. Cap construction began as soon as the piles for one bent were driven, cut off to the proper elevation, and fitted with bearing plates. Since it would have been too expensive and inefficient to build a form for each cap, reusable forms were devised. They consisted of floors which could be easily moved and separate sides which could be readily installed and removed. The sides were of ¾-inch plywood cut to the proper dimensions and braced with 2x4's on 2-foot centers. The floors were of ¾-inch plywood which rested on 6x6 timbers laid on two horizontal pieces of H-pile which were secured temporarily to the sides of driven pile. For removal, the horizontal H-piles were pulled away, allowing the floor to drop to the ground. Benches were easily removed and the components taken to another pier.

An assembly line was set up to fabricate rebar cages to be used in the deck slabs. To insure the proper distance between the upper and lower rebar mats in the cages, timber spacers were placed between the two mats. The spacers were removed after spot welding of the cages was completed.

Deck slab production goals were set at three spans a week. After being cast, the slabs were removed from their forms and stacked for curing.

Steel stock for stringers came in random 30- to 40-foot lengths requiring that all 162 stringers be spliced with a 100 percent penetration butt weld. This was a most time-consuming task. Butt welds were made with a 400-amp welder equipped with semiautomatic attachment. Since welding could be done only in a horizontal position, each stringer had to be rotated three times during the splicing. An ultrasonic flaw detector was used for inspecting the butt welds. Welding operations continued day and night to insure maximum utilization of welding facilities. Some clip angles for diaphragms were installed on the ground to reduce the amount of welding to be done after the stringers were set. Stringers were set on the caps by a 40-ton crane rigged with a spreader bar. All six stringers for a span were set and welded to their sole plates in one day. Diaphragm installation followed with the welding conducted continuously. Normally, the diaphragms were spot welded into place during daylight so that night crews need be concerned only with making final welds.

Deck sections were set by the crane working from the construction causeway. For a given section the two exterior slabs were set first, followed by the one interior slab. It was important that deck slabs be set in their final place as fast as possible so that the subsequent tasks of curb, handrail, lighting, and grouting installation would not be held up. Accordingly, welding was initially done only on top. Later a crew working from scaffolding on the bed of a 5-ton dump truck came back and made the underneath welds.

Lateral bracing had to be installed on the piers to bond the individual piles together. Braces consisted of horizontal members made of channel iron and diagonal members of angle iron. Each pier had to be individually tailored—a slow process. As certain crew members began to get the knack for fitting odd cuts, they were assigned the same pieces repeatedly to speed the welding operations.

Curb construction proceeded rapidly at the rate of 1½ spans per day with the use of reusable forms. The roadway of the bridge was paved in two days (east lane on the first day, west lane on the second). The lighting system was installed from scaffolding resting in dump truck beds. Driving pipe for the pier protection system and installation of the chain link fence around the pipe posed no particular problem.

This great bridge was passing traffic less than eight months after it was started, and was turned over to the Vietnamese Government in September 1970.

TME

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Contractors in the Combat Zone

By Col. Warren S. Everett, United States Army, Retired

From the point of view of the military engineer, one of the most revolutionary developments of the Vietnam War has been the unprecedented use of civilian contractors on most of the construction and facilities maintenance requirements of the military forces in Vietnam. Since there was no general call-up of American Reserves for duty in Vietnam, the Army had to place major reliance on civilian contractors for facilities engineering services. While these services were adequate, problems were encountered in contract administration.[1]

The debilitating climate of the country, health hazards, austere living conditions, and the long lead time required for resupply of materiel and replacement of personnel were aggravated by the direct enemy activity against military installations, the insecurity of surface routes of communication, and the restrictions placed on foreign contractor personnel by the Vietnamese Government. That adequate services were provided under such circumstances is a tribute to the adaptability of the American engineering contractor.

GOVERNMENT-CONTRACTOR RELATIONSHIPS

The organization for administering facilities engineering contracts is shown in Figure 1 [opposite page]. The U. S. Army Procurement Agency, Vietnam (USAPAV), has administered the contracts and monitored and reported on the adequacy of the contractors' management. Surveillance of the contractors' operations has been a function of the U. S. Army Engineer Command, Vietnam, and its District Engineer and Installation Engineer field representatives.

The contractors have generally paralleled the Army Engineer Command organization by establishing a Contract Management Office and by assigning a District Representative and an Installation Manager to work with the corresponding military engineers. Support maintenance has been provided by an Equipment Maintenance Group established at each of the major logistic support bases. Under each group is a Technical Supply Activity, a Fixed Field Maintenance Shop, and a number of Field Maintenance Teams.

This organization has worked very well, the most significant problems, from the contractors' point of view, being caused by the rapid turnover of their military counterparts. Troop support did not suffer on this account because the continuity of operations could be maintained by contractors' employees who had a much less rapid turnover rate.

TYPES OF CONTRACTS

Cost plus fixed fee.—In the beginning, most of the facilities engineering and support maintenance services were procured by negotiating cost-plus-fixed-fee (CPFF) contracts with American contractors. The CPFF contract is of a cost-reimbursement type which provides for the payment of a fixed fee to the contractor irrespective of the allowable costs incurred by the contractor. After several years of experience with the CPFF eontracts, it was apparent that they provided the contractor with little incentive to seek a high standard of technical performance at minimum cost. This type of contract also placed a heavy burden on the Contracting Officer because, to hold down contract costs, it was necessary to maintain close control over the contractors' personnel ceilings, recruitment procedures, position classification, and wage scales. At the same time, the Engineer Representatives, who had to achieve a high standard of technical performance, were not always satisfied to act only as monitors and in many cases pre-empted day-to-day management to such an extent that the contractors had only nominal authority over their manpower and resources.

Unlike the simple, mission-type CPFF contract form used in Vietnam by the Navy for its contract with the major American construction contractor, a long and complex CPFF contract form was developed for facilities engineering, specifying in detail how the contractor must comply with the methods set forth in dozens of separate publications which the Army had developed to control facilities engineering for Army garrisons in noncombat areas.

Cost plus award fee.—In an attempt to provide a greater incentive to the contractor, the contract form used by the Army for facilities engineering services in 1970 was a cost-plus-award-fee (CPAF) type. This is a cost-reimbursement contract with special fee provisions. "The amount of award fee to be paid is based upon a subjective evaluation by the Government of the quality of the contractor's performance, judged in the light of the criteria set forth in the contract."

Among the benefits from CPAF contracting, as compared to CPFF contracting, are better communication between government and contractor personnel at all levels, and between the contractor's management personnel and workers; better work definitions; and greater latitude in contractor control of his personnel and activities.

These benefits were realized by moving to CPAF contracts for procurement of facilities engineering services in Vietnam, but limited progress was made during 1970 in developing simple, clear statements defining the results the contractor was expected to achieve. It was, therefore, necessary for the government to continue to exercise considerable control over the administration and operations of contractor personnel. Nevertheless, the 1970 facilities engineering contract resulted in a significant improvement in the level of the contractor's technical performance and economy of operations.

Cost plus award fee with cost incentive fee feature.—The 1971 contracts for facilities engineering services in Vietnam retained the award fee but added a cost incentive provision under which the contractor would partly reimburse the government for any overrun in the agreed cost of the contract, but would be entitled to share, to a limited extent, in any net savings effected. To insure that the contractor would not be tempted to save costs at the expense of unsatisfactory performance, the contractor's share in a cost underrun would increase as his level of performance increased; and the contractor would not receive any compensation for a cost underrun unless his performance rating exceeded 60 percent.

The 1972 contracts are similar to those in 1971 except that improvements were made in simplifying and clarifying the criteria for the desired level of contractor performance in each functional area. The criteria could be further simplified by developing brief mission-type statements defining the results the government desires in each functional area, and then giving the contractors maximum latitude to work out their own methods for achieving the results. Also, now that the contractors have an adequate financial incentive to control their personnel costs, it is not necessary for the government to continue close control over the contractor's personnel arrangements.

PERFORMANCE EVALUATION

Experience in Vietnam has demonstrated the need for clear statements describing the contractor evaluation which should be applied in the administration of CPAF contracts. The statements for evaluation of facilities engineering contractors in Vietnam are summarized as follows:

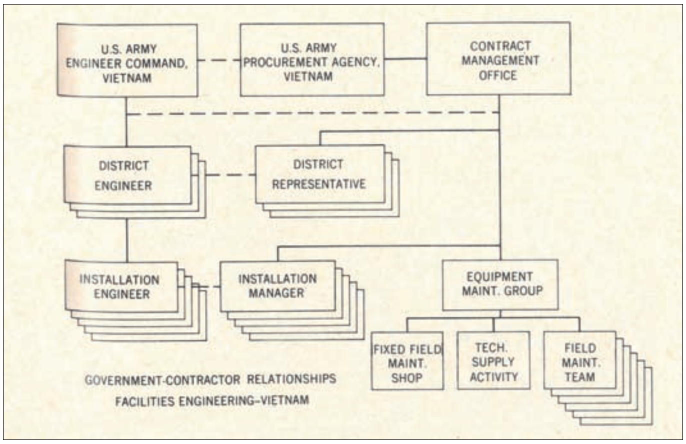
1. Evaluations will be such that the contractor is afforded an opportunity to earn a maximum rating in any functional area in which his level of performance meets or exceeds that which could reasonably be expected under the circumstances.

2. The contractor shall not be penalized because of any government inability to meet its contractual commitments or failure to carry out its responsibilities because of government-directed diversion of resources or because of the substandard condition, inadequate design, or inadequate government records of facilities or equipment furnished by the government. In cases where the contractor is forced, because of lack of adequate facilities, authorized equipment, or repair parts, to use unsafe or substandard facilities or equipment, his performance ratings shall not be downgraded provided he is making the best use of the resources available to him.

3. Government rating officials shall explain to the appropriate representative of the contractor the reasons for any rating less than the maximum, so that the contractor may know what specific improvements or corrective actions are required to qualify for a maximum rating.

GOVERNMENT-FURNISHED PROPERTY

The CPAF construction contracts which the Navy administered in Vietnam authorized the contractor to procure and maintain his own facilities and equipment. The Army-administered facilities engineering contracts, on the other hand, generally required the contractor to make use of government-furnished facilities and equipment. Facilities engineering contractors were authorized to procure their own facilities and equipment only after approval by the Contracting Officer on a case-by-case basis. Thus, facilities engineering contractors were placed at the mercy of the Army supply system at a time when it had to give priority support to the combat requirements of military units. In these circumstances, contractors were obliged to use makeshift and inefficient administrative and shop facilities and to salvage and rehabilitate large quantities of substandard equipment which military units had turned over to property disposal yards. This hampered the contractors in meeting their responsibilities. They should have been allowed greater latitude in using their own channels for procurement.



GOVERNMENT-CONTRACTOR RELATIONSHIPS
FACILITIES ENGINEERING–VIETNAM

VIETNAMIZATION

Along with the rapid redeployment of American Forces from Vietnam has come the need to speed up the Vietnamization program. At the same time, the Government of Vietnam has begun to reduce the Third Country National work force of all American employers. Because of these developments, the scope of work under the facilities engineering contracts has been expanded to include programs for training Vietnamese civilian and military personnel in the technical and managerial skills used in facilities engineering. On-the-job training has been provided for over 45,000 Vietnamese, and formal training has been provided for more than 10,000.

CONCLUSION

The Vietnam War has demonstrated that civilian contractors can be successfully used for facilities engineering services in an active combat zone under limited war conditions. Use of cost-plus-award-fee contracts with cost incentive has proved to be a most effective means for procuring such services. These contracts could be improved and simplified by developing terse and clear-cut performance criteria statements limited to definition of the end result desired in each functional area, by encouraging contractors to exercise maximum ingenuity in devising their own methods to fulfill their contracts at the least possible cost, by limiting government surveillance to the evaluation of the quality of the end results achieved, and by allowing contractors greater freedom to control personnel cost in their own way and to use their own channels for procurement of needed facilities and equipment. TME

[1] According to the 1970 report by the Joint Logistics Review Board on Logistic Support in the Vietnam Era.

First published in The Military Engineer, January-February 1972.

U.S.-ARVN Engineer Training

By Maj. Robert W. Whitehead, Corps of Engineers, United States Army

The South Vietnamese Army Engineers are assuming more and more of the engineer-construction burden from their American allies. They are demonstrating that they have the desire and soon will have the competence to take responsibility for much of the engineer mission in South Vietnam. This is in accord with the Vietnamization policy of the United States.

Over the past few years, United States Army Engineers and Republic of Vietnam Army (ARVN) Engineers have participated in various training programs with the aim of developing the engineering skills of the Vietnamese forces. Until recently, the Vietnamese have used their skills mainly in support of their combat units and base construction. It was in October 1968 that a formal program was begun of affiliation of American units with ARVN Engineer units to encourage technical assistance and joint project execution. The accomplishments of this program were primarily at the local level and included on-the-job training (OJT) of Vietnamese equipment operators and mechanics, assistance in quarrying, work on several joint projects, and limited technical assistance. In March 1970, the continuation of these efforts was authorized[1] through liaison with the Military Assistance Command, Vietnam (MACV) advisors on an area basis between specific affiliated American and ARVN Engineer units. The result is the present U. S.-ARVN Engineer Affiliation Program which is composed of three elements: mutual association, mutual co-operation, and training assistance (OJT). Mutual association refers to any relationship which enhances mutual respect and firm ties between American and ARVN Engineer commanders. Mutual co-operation is the execution of engineer tasks by combining resources of affiliated units. Training assistance (OJT) is the process whereby ARVN Engineers acquire knowledge and skills by working under competent American supervision.

Vietnamization of the engineer mission is the objective of this program. It is being met by expansion of the ARVN Engineer construction force, modernization of their equipment, training of personnel, and turnover of various engineer projects (including part of the LOC highway restoration program) to the ARVN Engineers. At the beginning of 1969 there were eight ARVN Engineer construction battalions organized into two construction groups. Now, there are seventeen battalions organized into four construction groups. Each group has from three to five construction battalions, a dump truck company, and a heavy equipment company. The USARV Engineer Command provides their equipment through an authorized equipment transfer program.

The training of the ARVN Engineers remains as the highest priority mission of the USARV Engineer Command. This is an important program and one that will affect nation building in Southeast Asia in the years to come. While the over-all objective is to increase the RVN Army Engineer capability, the skills gained by the soldiers will enable them to handle future construction and maintenance problems.

Each United States Engineer Group

is conducting a training program with the ARVN units in its respective areas of responsibility.

Specifically, ARVN Engineers are learning asphalt plant and paving operations from the 159th Engineer Group units. The Vietnamese have constructed and are operating their own plant and are upgrading a 67-km stretch of highway in the Saigon region. The 159th Engineer Group/ARVN training and cooperative programs include Project BUDDY (engineer equipment maintenance OJT), in which Vietnamese Army Engineer mechanics are taught organizational through direct support maintenance of engineer equipment; OJT training in the operation and maintenance of the asphalt finishing machine and asphalt distributer, continuous mix asphalt plant and scrapers; and OJT conduct of quality control, making analytic tests using field samples and making inspections on the job site.

The 79th Engineer Group (C) was extensively involved in the Land Clearing Vietnamization Program through its 62nd Engineer Battalion (Land Clearing). For two weeks, the Vietnamese Engineers studied the care and maintenance of land-clearing equipment while others were taught to operate and maintain the tractor trailers which transported the Rome plows. Most teaching was by the Buddy System—each American operator working with and teaching his South Vietnamese counterpart. Daily classes were held for the Vietnamese in the English language to improve communications.

Along with other programs, the 34th Engineer Group is assisting the 7th ARVN Engineer Group in upgrading a section of Highway 4 in the Delta area.

The training of the ARVN Engineers remains as the highest priority mission of the USARV Engineer Command. This is an important program and one that will affect nation building in Southeast Asia in the years to come. While the over-all objective is to increase the RVN Army Engineer capability, the skills gained by the soldiers will enable them to handle future construction and maintenance problems.

The 35th and 937th Engineer Groups are providing formal instruction in the operation of engineer equipment, and the 45th Engineer Group has found OJT programs to be successful with the ARVN units in its area. The Tuy Hoa Bridge, jointly designed by the 20th ARVN Engineer Group and the American 18th Engineer Brigade, is an extensive joint venture with the Americans assisting in pile driving, providing lift equipment, training operators and welders, and assisting in the procurement of materials and equipment. In Operation DUAL BLADE II, an ARVN and American Engineer battalion co-operated in the construction of steel multiplate arch shelters. The 61st ARVN Engineer Battalion is currently upgrading 50 km of Highway 1 from Long Lam to Tuy Phong.

The South Vietnamese Army Engineer Group and Battalion commanders are invited to participate in meetings on engineering problems, distribution of engineer work, highway construction, and other pertinent engineer subjects. Personal association of American and South Vietnamese commanders and men is being developed through participation in training programs, joint efforts, and mutual co-operation. TME

[1] By a Memorandum of Understanding Between MACVJ4 and CG, U. S. Army Engineer Command, Vietnam (USAECV) defining procedures governing USAECV training assistance to RVNAF Engineers. The memorandum recognized the benefits of the past voluntary programs of affiliation and co-ordination.

First published in The Military Engineer, March-April 1972.

Vietnam: In Their Words

SAME members who served in Vietnam share personal stories about their time "in country."

On the Way to an Adventure

This story begins in late April 1966. I started the travel from Fort Bliss and from my family, dressed in greens with a bag containing several sets of fatigues and my personal items. I spent the night with a friend in California, who packed and then sent my greens back to Texas. Being an enthusiastic young captain, with replacement orders in hand to the 864th Engineer Battalion in Vietnam, I boarded that big silver bird on the way to an adventure.

After crossing the International Date Line, we arrived at Bien Hoa, outside Saigon on May 2, 1966. The planeload of new guys and I reported to the Replacement Depot for assignment to temporary quarters. I expected to be processed and sent to Cam Ranh Bay to join the 864th. Well, that didn't happen. After two days of getting acclimated, I went inquiring about the status of my transfer. Finally I was informed by a veteran first lieutenant that those orders from Washington only got me into country. The Replacement Depot would make the final decision about where I was headed. He further informed me that the best thing I could do was return to the barracks and relax. They would be in touch with me in due time. My gosh! Didn't he realize there was a war going on? I couldn't possibly relax with the fate of the free world hanging in the balance.

With not just a little luck, I found the U.S. Air Force Transportation Operations Center and was told there was a C-130 going to Cam Ranh Bay at 1700. The pilot and crew were having coffee in the next room. Such an opportunity was too good to pass up. I went in, introduced myself, showed them a copy of my orders, and we struck a deal. They would help me get in touch with the battalion. The battalion then would meet the aircraft with six roast beef sandwiches at 1800 hours.

That seemed simple enough, I thought. We'd see. The arrangements were made after about four hours of trying to establish communications. I had just enough time to pick up my meager belongings and get back to the flight line.

Once we were airborne, communications became much easier, faster, and more reliable. All the arrangements were confirmed, and, to my amazement, a jeep with 12 of the most beautiful roast beef sandwiches was waiting as we taxied to a stop. After transferring the food and saying our goodbyes, I was finally on the ground and on my way to my first assignment in Vietnam.

However, the adventure did not end there. It normally rains in May—and May 1966 was no exception. The 864th Engineer Battalion had built the road from the airbase to the south end of the peninsula, where they were located on the beach in tents, and had dispatched several teams to make sure the drainage structures were performing as originally envisioned. Our headlights illuminated one of the team's trucks seemingly abandoned on the side of the road. As we got closer, we could see team members on the edge of the streambank above the inlet of a large culvert running under the road. We stopped to see what was going on and asked if we could be of assistance.

As we got closer, we could see team members on the edge of the streambank above the inlet of a large culvert running under the road. We stopped to see what was going on and asked if we could be of assistance.

The officer in charge of the team informed me that sand and debris had started to clog the culvert and they were attempting to reopen it to reestablish full flow. His method for clearing was to strap a grenade to a piece of wood and let it float into the culvert in hopes the blast wave would dislodge the sand and debris. It was not a method that I was familiar with, but he seemed to know what he was doing. I further inquired why he had his boots off and was stomping around in the shallows near the culvert mouth. With a straight face, he said that while attempting to fasten a grenade to a piece of wood he had dropped the grenade and was fishing around with his foot to see if he could find it. With that explanation firmly etched in my mind I wished him good luck, and indicated that I needed to get on to battalion headquarters.

The rest of the evening was filled with seeing old friends and making new friends—and it ended without further mishap or drama.

–Lt. Col. William Mills, USA (Ret.)

Our Corner of Phu Bai

I began my Vietnam tour in the fall of 1968.

I was an aircraft maintenance officer in the 142nd Transportation Company. We were sent from Fort Campbell, Ky., to Phu Bai, Republic of Vietnam, becoming B Company, 5th Transportation Battalion, 101st Airborne Division.

Phu Bai was a base surrounding Hue airport, about 45-mi from the Demilitarized Zone, used by U.S. Army and Marine aircraft units. We arrived in the middle of monsoon season, assigned to unoccupied area off the end of the runway. Our battalion headquarters and A Company were a few miles away at Camp Eagle. With my engineering degree, the commanding officer gave me the unofficial job of getting our area developed, coordinating with division and base command structures. As a civil engineer, but wearing Transportation insignia, it took a lot of persistence to get any action. I began by mapping our assigned area and the few hootches built for our advance party that had arrived earlier. With no surveying equipment, I used a lensatic compass and a 100-ft tape to map our area. Afterwards, I drafted a site evaluation of soils and drainage to plan our faculties.

In addition to the planning, I had a small crew to scrounge material and equipment, and build ancillary buildings and our own utilities.

I replaced the ubiquitous "cookstove-under-55-gal drum" showers that froze the first users and scalded the later ones, designing heat exchangers using copper tubing around immersion hearers. They were fed via buried hose from a water tower we built from a salvaged fuel tanker, and we acquired piping and valves to equip the showers with hot and cold running water.

Headquarters and A Company had appropriated half of our generators because we had arrived with new equipment. But we procured a "hopeless" 100-kw three-phase generator from a Marine unit by lending them a truck. We had a warrant officer with experience in diesel engines and another with expertise in electrical distribution. We built a dedicated shed for the generator and soon had three-phase, pole-mounted power distribution around our entire company without the angry buzz of dozens of small generators. In a few months, our corner of Phu Bai had better facilities than anywhere outside of Saigon or Da Nang.

To build a motor pool on lower ground that had been rice paddies, we needed to move our perimeter outward. I put an E-7 in charge of a small crew to pull and move the concertina wire. The deep sand that had spread in a mini-delta from a creek, though walkable, was "quick" and unable to support the load or vibration of vehicles. I warned him to work by hand with no vehicles. No doubt he thought, "What's this kid lieutenant know, anyway?"

When I returned he'd sunk a jeep to its floorboards, then a thee-fourths ton trying to pull it out, then a duce-and-a-half and finally a 5-T semi tractor—all looking like a daisy chain! I got a nearby engineer unit to pull them all out with a D-7 (and was listened to afterwards).

Much, if not most, of our resources came from "scrounging," which was typical of the place and time. That effort was essential to constructing the buildings and facilities that were needed but were not on the Base Development approval list (imagine a kind of Planning and Zoning Commission). There are lots of stories about those efforts, but no room here.

–Gene Rovak, P.E., CFM

Concrete Mixing and Paving in Vietnam

From after World War II to the early 1960s, the U.S. Army's standard paving equipment was the 34E Paving Train, a machine with a loading skip, mixer, and cable and bucket system for placing concrete. In 1965, two concrete mixing and paving (CM&P) detachments were formed at Fort Leonard Wood, Mo. These were the Army's first units of this type, equipped with commercially available equipment to make the transition to a ready-mix concrete plant and slip-form paving. Each unit was equipped with a batch plant, a slip-form paver, front-end loaders, water tankers, and a fully equipped concrete laboratory for preparing test mixes and testing hardened concrete.

In early 1966, after finishing a 10-week Engineering Officer Basic Course and spending three months as Executive Officer of an advanced individual engineering training company, as a second lieutenant, I was assigned to the 39th Engineering Detachment (CM&P) as Commanding Officer. 2nd Lt. John E. Parker III, USA, was assigned to the 444th Engineering Detachment (CM&P). Each unit also consisted of 26 enlisted personnel. Prior to delivery of the new equipment, we travelled to the manufacturers to familiarize ourselves with the equipment, and then developed a training program for our units. Upon delivery of the major equipment components, we spent two weeks gaining hands-on experience mixing and placing concrete. The equipment was then prepared for overseas shipment, loaded onto rail cars, and sent to the West Coast for ship movement to the Republic of Vietnam.

My detachment, the 39th, set up operations at Cam Ranh Bay in the then-largest military quarry in the world, operated by the 864th Engineer Battalion (Construction). It was during my time in Cam Ranh Bay that I joined the local SAME Post.

Our batch plant consisted of a mixer, a cement silo, and an aggregate batching plant. All the units were towable, and the design of the mixer and cement silo allowed them to be tilted up into their operating positions.

The batch plant was capable of producing 106-yd^3 of concrete per hour, primarily for the floor slabs of warehouses and housing buildings. The quarry provided crushed, graded aggregate; adjacent sand dunes provided sand; and a nearby lake provided water. Pallets of cement were brought in by ship. Individual bags were broken into an elevator that carried the cement to the top of the cement silo.

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Because of the soft, sandy soil of the area, the batch plant also produced a mixture of soil cement that was used as a base for asphalt pavements. The slip-form paver was used a few times; but roads were generally constructed of asphalt produced in the same quarry. Dump trucks weighing 5-T transported all concrete to the work sites. Often, because of the heat, it was more advantageous to place the concrete at night when the temperature was lower and the concrete could set more slowly.

In February 1967, I became the quarry officer and supervised the drilling, blasting and crushing to produce aggregate. That job also had me conducting reconnaissance investigations of potential quarry sites, and we initiated the development of a new satellite quarry operation for construction aggregate.

In July 1967, I was assigned as the Battalion Civil Engineer. One month later, I left active duty with an honorable discharge. I returned home to Chicago and went to work as a structural engineer. After about 12 years, I started my own firm. We are celebrating our 37th anniversary this year.

– Thomas Collins, P.E., S.E.

VIETNAM:
April 1970 – April 1971

I graduated from the University of Notre Dame with a degree in Mechanical Engineering in June 1969. About a year earlier, I had applied for and been accepted to Naval Officer Candidate School at Newport, R.I.

So six weeks after graduation, off I went to begin my military career. I spent about four months at Newport and then four more at the Naval Civil Engineer Corps Officers School in Port Hueneme, Calif.

In early April 1970, I reported for duty to Chu Lai, Republic of Vietnam, as a rather overwhelmed 22-year-old ensign ready to serve as Bravo Company Commander with Construction Battalion Maintenance Unit (CBMU) 301.

CBMU 301 was tasked with operating and maintaining the Chu Lai Combat Base, home to Marine Aircraft Group 12 and the U.S. Army's 23rd Americal Division. Bravo Company, consisting of 60 of the hardest-assed Seabees you could ever imagine, focused on operating, maintaining and repairing the jumble of utility systems—electric, water and telephones—that had been built over the years and serviced the base.

During the summer of 1970, the Army assumed operations and maintenance of Chu Lai, so CBMU 301 was decommissioned and sent back to the United States. However, since I only had about five months of service "in country" at the time, it was determined that I should stay in Vietnam and finish out the one-year tour I had been scheduled for.

Officially I was re-assigned to Naval Support Activity Saigon in the south; but operationally I was transferred to one of the most northern parts of the country (the Northern I Corps Tactical Zone as it was called) to serve as Officer in Charge of Construction for part of the new Intermediate Support Base Thuan An—on the coast about 30-km south of the Demilitarized Zone between North and South Vietnam. Intermediate Support Base Thuan An was being constructed to provide fuel, maintenance and other logistical support to river and coastal patrol boats as part of the "Vietnamization" of the war.

My detachment consisted of about 25 Seabees. Our assignment was to build housing for families of the Vietnamese sailors assigned to the base. Since the main base was just being finished, my men and I were billeted at the nearby Army Tan My fuel storage depot. You would think that 25 grizzled Seabees and about 125 equally seasoned Army specialists would get along like oil and water, but we somehow managed to co-exist rather nicely.

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When the new base and housing were completed, about half of my Seabees stayed on—as did I—to start up and operate the facility and eventually turn it over to the Vietnamese Navy. I was now a lieutenant junior grade and was given the joint role of Executive Officer/Public Works.

When my year's tour of duty approached conclusion, I was anxious to know where my detailer was going to assign me next, as I still had about 20 months to serve on my commitment. Due to cuts in the defense budget for the coming fiscal year, however, that new assignment never came. The only official message I ever got was "Early Out"—meaning that when my tour was over, I would become a civilian again. I had never intended to make the Navy a career, but I certainly expected my stint to last a little longer than 16 months!

On April 8, 1971, I flew out of Da Nang aboard the most beautiful American Airlines Boeing 707 ever built and headed to Norton AFB in California to begin the rest of my life.

While it was not the most pleasant year I ever spent, the experience I gained in Vietnam was invaluable. The leadership and interpersonal skills I developed in that very difficult environment served me well throughout my professional career.

–Thomas Dickmann, P.E., F.SAME

The Personal Touch

In December 1971 and January 1972, I was the Rear Detachment Commander of the 554th Engineer Battalion (Construction) stationed at Long Binh, Republic of Vietnam.

The detachment consisted of nine persons with the mission of expediting the movement of supplies, equipment and personnel from Long Binh to the battalion base at Bao Loc approximately 100-mi away on QL 20.

During this period, the 554th Battalion was being deactivated under the Keystone Program. This program allowed a battalion 60 days to turn in all assets and transfer all personnel. The battalions were expected to continue their missions as long as possible. For most, this meant continuing to upgrade various roads as part of the Lines of Communication program.

The Keystone Program provided for a free turn-in of equipment. An item did not have to operable to be turned in at the depot and cleared from the property book. The first items turned in were typically the mechanic's toolsets. Maintenance stopped and any vehicle or piece of equipment that broke down was immediately hauled to Long Binh for delivery to the depot.

Prior to the notification of deactivation, the battalion had run a convoy from Bao Loc to Long Binh three or four days a week. With the deactivation activity, that became a convoy every day. We would have a convoy arrive late in the afternoon, unload, spend the night, and then depart back to Bao Loc the next morning. With the lack of maintenance, there were frequent breakdowns during the convoys. Three to four times a week we had to recover a disabled vehicle.

At that time, with the exception of an advisor group in Dinh Quan and two artillery fire bases, there were no U.S. units between Bien Hoa and Bao Loc along QL 1 and QL 20. Fire Support Base (FSB) Michelle and Fire Support Base Nancy each had half of A Battery, 5th Battalion, 42nd Field Artillery Regiment. Both bases had three towed 155-mm guns and two sections of Quad 50's mounted on 5-T trucks.

The engineer units did not have formal fire support associations. One day, I stopped at FSB Michelle, some 2-mi west of the intersection of QL 20 and QL 1 and beside QL 1. I wanted to do some informal coordination for fire support, in case we had a problem during a recovery operation (these operations frequently stretched into the night hours). When I got to Michelle, I was stunned to find the battery commander was a friend from college, Bill Reeder. Bill had been a junior in the fall of 1963 when I was a freshman. We were both in the Pershing Rifles Company. We talked about fire support and traded call signs and frequencies. Bill indicated that if his higher headquarters agreed, he would have no problem helping us.

We would have a convoy arrive late in the afternoon, unload, spend the night, and then depart back to Bao Loc the next morning.

About three weeks later we found ourselves stranded on QL 1 about 1-mi east of Michelle with seven people, two jeeps, two 10-T tractors, two broken down trailers, a bulldozer, two radios, five M-16s, two .45 pistols and an M-79. When I talked to the support unit commander at Long Binh, the word was: "Find a hole and pull it in after yourselves. 1st Cav just found what appears to be an NVA regiment in the rubber plantation between you and Long Binh."

With that news, we dropped the trailers, disabled the bulldozer, and headed for Michelle. The guard did not want to open the gate, so I asked him to call for his commander. When I saw him approaching the spotlighted area around the gate, I called out, "Hey, Bill. It's Denny. Can we spend the night?" This cut through a lot of suspicion and protocol to get us through that gate. That evening is a valuable reminder there is no substitute for personal coordination, a fact too frequently forgotten in our modern world of communication.

–Faust Denis d'Ambrosi, PMP

**Thanks to Bill Reeder for allowing me to use his name and for telling me his unit's designation. I didn't know it until now.–F.D.*

From West Point to Vietnam

After graduating from West Point and completing Airborne and Ranger Schools, I traveled with my new bride in November 1965 to Munich, Germany for what I expected to be a three-year assignment with the 3rd Engineer Battalion, 24th Infantry Division. However, after six months, I was on orders to Fort Lewis, Wash., to be part of the activation of the 93rd Engineer Battalion (Construction). I arrived there in July 1966.

Then in February 1967, I was told I was to become the Battalion S-4 (Supply Officer) and start a seven-week Supply Officer's Course at Fort Lee, Va., the following week. So my wife and I packed up our Volkswagen and began the trek across the country. We drove 2,400-mi in three days and decided to leave our car in Houston with a relative and fly to Washington, D.C., where we would pick up a car from my parents and drive to Fort Lee.

Following the Supply Officer's Course, my wife and I flew back to Houston and picked up our car, then headed back to Fort Lewis, this time taking two weeks rather than three days. We arrived in late March, just in time to prepare the battalion for deployment. I was in the advance party that flew to Vietnam on June 8, 1967, while the majority of the soldiers and equipment was transported and arrived some two weeks later.

The battalion was assigned to one of the primary base camps of the 9th Infantry Division called Bear Cat. The base was near Long Binh, about 50-mi from Saigon. The mission was to establish a battalion base camp and construct facilities at the Long Thanh airfield. There were no existing facilities for the base camp so we positioned the battalion adjacent to the airfield, which had a runway, taxiway and limited supporting facilities. As the Battalion S-4, it was my job to procure the construction materials needed to construct the base camp of administrative offices, barracks, mess halls, shower facilities and utilities. I frequently drove from Bear Cat to Saigon in a jeep, most times with a driver but sometimes on my own. Since we were not the only unit setting up a base camp, the acquisition of construction materials became a major challenge, requiring some good negotiation skills to get what we needed and delivered to our location.

In October 1967, I was promoted to captain and took command of Company D, 93rd Engineer Battalion, which had about 250 soldiers and a substantial amount of construction equipment. We had major projects on the airfield, including constructing a taxiway, parking aprons, revetments for Huey helicopters and fixed wing aircraft, a passenger terminal, water tower, aircraft hangar, dining hall, and a dog kennel. Constructing airfield facilities was a high priority. We operated equipment 24/7. I would often go out to visit our projects and in the evening could be seen operating a tractor-scraper or dozer. We had to move a substantial amount of dirt, much of it composed of laterite.

Part of the engineer effort in Vietnam was the development of the Vietnamese Corps of Engineers. My company developed and instructed Vietnamese engineers on the design and construction of timber trestle bridges. We also did some work in support of the Vietnamese, including a civic action project that replaced a failing bridge over a major highway with a modern structure.

I changed command on May 22, 1968 and returned to the United States with a deep appreciation of the capabilities of military engineering in a combat zone.

During my time in Vietnam, the draft was the primary way the Army recruited soldiers. Some had a great attitude and others were there only because they were drafted and could not wait to leave. The Army also allowed some soldiers to re-join and gave them a promotion from their grade when they left the service. This often elevated some soldiers above their leadership capabilities. As a young officer, I found it a challenge to lead and motivate this diverse group of draftees.

The units of the 93rd Engineer Battalion had an amazing list of accomplishments that were made possible by the talents of the engineer soldiers. Many of the drafted soldiers came into the Army with skills as carpenters, electricians and equipment operators that contributed to the battalion's mission. Others went through Army schools on the way to Vietnam. In either case, we were never unable to accomplish a mission due to a lack of engineering or construction expertise.

I have often told people that despite being away from my family for a year in a combat zone, serving with the 93rd Engineer Battalion in Vietnam was truly one of the most challenging and rewarding assignments in my military career. Perhaps one day I will return to see if the Long Thanh airfield is still there.

–Lt. Col. Robert Wolff, Ph.D., P.E., F.SAME, USAR (Ret.)

Reflections on Vietnam, 1967-1968

During the second phase of the Tet Offensive in early 1968 enemy troops infiltrated sections of Cholon, a part of the Saigon metropolitan area.

U.S. Forces engaged the enemy, including considerable aerial bombardment and artillery fire. One estimate was that 10,000 residences had been destroyed. Local news media were very critical of the damage done to the civilian population and their dwellings. Gen. William Westmoreland, USA, Commander of U.S. Military Assistance Command, Vietnam (MACV), was personally concerned by this criticism. He sent for Brig. Gen. Andy Rollins, the Director of Construction and instructed him to get busy and build replacement housing. He wanted well over a thousand units, and the directed schedule was a very demanding eight weeks. After that meeting Gen. Rollins told me, a lieutenant colonel on his staff: "Well Chuck, you've got a job."

Happily, a very high priority on men and materials accompanied the mission. It was clear that we'd need to deal extensively with Vietnamese civilian authorities and with officials of the Army of the Republic of Vietnam (ARVN). We needed an approved structure design; real estate on which to locate the units; and coordination with municipal utilities to obtain services. Then there was a question as to how much material would be needed, and how, when, and where it could be obtained. What was the construction strategy to be? Considering the demanding schedule, some measure of pre-fabrication appeared essential. How would parts or whole units be transported to an erection site? Saigon traffic was pretty dense and unforgiving. What equipment would be needed? Who would be invited to occupy the units?

The units were small, fairly square wooden structures with a single drop cord electric light in each, and one wall outlet. A single cold water tap was installed outdoors to service each four units. There were no windows, just screened openings for ventilation and insect control. Roofing was corrugated galvanized metal sheets. More often than not, the foundation consisted of short stacks of concrete blocks. In most of the units there was only a dirt floor. The legal complexities of securing real estate was left to ARVN officials, and they performed very well.

The Phu Tho racetrack, not far from MACV Headquarters, seemed to be an ideal site for pre-fab operations. It was large, flat, and somewhat protected. An engineer combat battalion was assigned the mission. They built pre-fab jigs to position pre-cut lumber and hold elements steady as they were connected. Pre-fab elements included wall panels and roof sections. These elements were loaded on low boy trailers and transported to the building site where they were erected, connected, and wired.

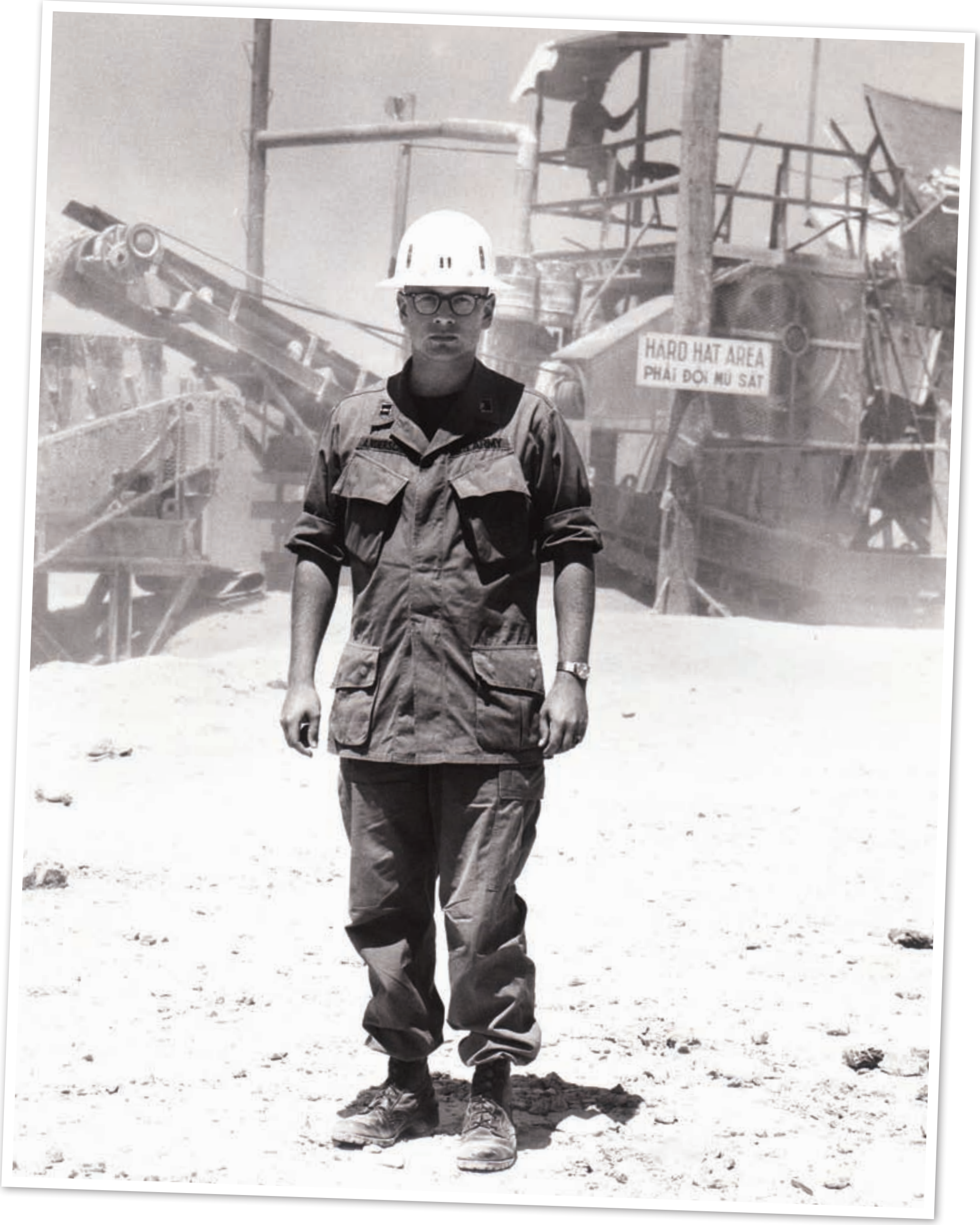
Residents took enormous pride in their new abodes, especially the parts that they conceived and built with their own hands.

Families were selected for occupancy by civilian Vietnamese officials before the places were finished. Each family was authorized “10, 10, and 10” (10 sacks of cement, 10 sheets of corrugated metal roofing, and 10,000 piasters in cash). Aggregates were delivered and piled near the new units, and a small concrete mixer was made available. Residents scavenged more material. Some laid a concrete floor in their unit; others nearly doubled the rain protected living area by building a covered "porch" out front. Residents took enormous pride in their new abodes, especially the parts that they conceived and built with their own hands.

Operation Dong Tam, as the mission was named, was a success.

Vietnamese officials were pleased, and I departed Vietnam with the happy feeling that through the mobilization of engineering and administrative talent we had accomplished quite a lot. Many innocent victims of the conflict were made safer and more comfortable, and the U.S. Forces proved to local Vietnamese that we were indeed on their side.

–Maj. Gen. Charles McGinnis, P.E., F.SAME, F.ASCE, USA (Ret.)



Nancy Sinatra's Sheets

I came to Vietnam via the 11th Engineer Group in Germany, where I had served as a Platoon Leader in the 535th Engineer Company (Light Equipment) and as Executive Officer and Commander of the 541st Engineer Company (Float Bridge). When I left Germany in October 1967, the 11th Engineer Group commander told me not to expect to command again as a captain as I'd had 16 months of company command. After I arrived in country I was in-processed at the 22nd Repo Depot in Cam Ranh and sent to the 35th Engineer Group. I was interviewed by the S-1, the S-3 and it seemed by everyone else. They all seemed interested in my time with 535th and wanted to know if I had any quarry and rock crusher experience. I told them I had. At dinner that night I was interviewed by the 35th Group Executive Officer and was told that I would get my assignment in the morning. The next morning I had breakfast with the Group Commander, Col. John Hughes, USA, and was told that I would be going up to the 864th Engineer Battalion in Nha Trang as "they needed a company commander."

As I waited for transport up to the 864th, several of the staff officers asked how I slept the night before and I said "Quite well." But that I had noticed that there were black streaks on the bed sheets. One of them said to me "Oh well, Nancy Sinatra was here last year for a USO tour and slept in that bed. We haven't changed the sheets since!"

The insinuation was that she had slept in that bed with her famous "walkin' boots" on!

I went up to the 864th, and was assigned command of "Alpha" Company, which had responsibility for a quarry and rock crusher complex at Ba Ngoi and at Nha Trang AB. In addition, we operated a 120-T/hr hot mix asphalt plant at the base and were responsible for a paving train and for Engineer Direct Support Maintenance for the entire battalion. The Ba Ngoi complex provided crushed base course rock for the rehabilitation of National Highway QL 1 from Dong Ba Thin all the way up to Nha Trang. I was fortunate to have some very good officers, warrant officers, NCOs and lots of good soldiers, and we were able to support all these demanding missions.

After the Tet Offensive, HQ 35th Engineer Group moved from Cam Ranh Bay to Qui Nhon and to the best of my knowledge, Nancy Sinatra's sheets were stripped off the bed!

-Col. Rick Anderschat, USA (Ret.)

From Da Nang to Site-X

When I joined Naval Mobile Construction Battalion (NMCB) 10 in late 1965, the battalion had returned to Port Hueneme, Calif., from its first nine-month tour to Chu Lai, Vietnam. It was the first Seabee battalion to country. I had previously been a Navy Seabee reservist and drilled at Jones Point, Va. Just before joining NMCB 10, I had passed the Navy-wide advancement exam and been promoted to Third Class Petty Officer, Equipment Operator, Heavy Construction.

By late March 1966, word was out that the next tour would take us to Camp Hoover, just north of Da Nang, near Hill 131—also known as "Freedom Hill."

My work site was located just outside of Camp Hoover and at the foot of Hill 131. I was assigned to Alpha Company, 1st Platoon, 4th Squadron and volunteered to operate a crane (Northwest 25) with clamshell. I had no crane experience other than working around heavy equipment on construction sites in the Washington, D.C., area and reading Navy instruction manuals. The operation at our concrete batch plant was to load aggregate with the crane clam in elevated hoppers. Tedious operation, but I learned quickly. The plant was adjacent to NMCB 10's large quarry where two Cedar Rapids rock crushers produced aggregate for concrete, backfill and base material. Sand was trucked from nearby Red Beach. The plant produced all the concrete for the many projects, including a regional Exchange facility, munition bunkers, road drainage structures, storage buildings, and an outdoor theater where Bob Hope did a Christmas show.

The operation mission was to construct the airfield runway within 32 days. We did it in 27, so C-130s could land and take-off.

Camp living quarters were strong back shelters for a 14-man squad and outfitted with typical military bunk beds and metal lockers. During our stay, we removed the canvas tent covering for the roof and replaced it with corrugated sheet metal for an improved living environment. My day started around 0500, first to one of two or three outdoor showers, then chow at the camp mess. The work site, quarry and batch plant were within walking distance. I picked up two spam sandwiches for lunch and worked throughout the day operating and maintaining the crane with clamshell, six days a week until sundown and sometimes on Sunday, but that was rare.

For maintaining and operating the equipment during the Da Nang deployment, I was awarded a letter and certificate of achievement signed by Gen. William Westmoreland. NMCB 10 received the Navy Unit Commendation. The battalion returned to homeport at Port Hueneme by mid-February 1967 and went through another training period in preparation for its third deployment. To stay with it for another operation, I accepted a field promotion to Second Class Petty Officer.

By July 1967, NMCB 10 was ready for another deployment. We knew very little about this next one, but I volunteered for an advance party of eight personnel to Camp Kinser (later renamed Camp Shields) on Okinawa Island. We flew out of Point Mugu on two C-118 prop cargo planes with supplies to setup battalion operations. The plane I was on sprung an engine oil leak and we made an unscheduled stop in Hawaii for repairs that took about five days. We made another stop at Midway Island before arriving at Kadena AB and then a short drive to Camp Kinser. The site had not been occupied for over a year. Clearing away overgrowth was the first assignment in addition to cleaning and repairing spaces for the eventual arrival of the battalion's main body.

Next, I was selected for Operation Foxtrot, to build a new air base, runway and support facilities for the 3rd Marine Air Wing. We were dubbed the "Ghost Battalion" and flew the skull and cross bones at Site-X, north of Quang Tri and south of Dong Ha. The air base at Dong Ha was always under fire from the North Vietnamese, and we were being fired upon during arrival.

Our field facilities were basic: two-person shelter halves over fox holes was our home for about three weeks until more permanent quarters were built. Meals were typical C-rats. On two occasions during the early airfield construction we were called to the defense line during an attack. Luckily, no losses. We had M-16 rifles—new for Seabees—but had access to M14s during this deployment. The operation mission was to construct the airfield runway within 32 days. We did it in 27, so C-130s could land and take-off.

Eventually, and following the first phase of runway construction, NMCB 10's camp was established at the north end of Site-X. Bedding was folding military style cots using an air mattress top. Duffle bags were our lockers. Between facilities, sand bagged shelters were erected for protection against rocket and mortar attacks. South of the camp was occupied by the Marine Air Wing and a Marine security company. East was the Qua Viet River and west was Highway 1, which ran from Dong Ha to Saigon. U.S. Army units surrounded us on the north and west of the highway.

NMCB 10 was at Site-X during the Tet Offensive. I had recently returned from a second rest and recuperation to Japan when we were nearly overrun, but U.S. support forces routed the enemy attacks. I never fired a shot. Within two months following Tet, my time on active duty came to an end. I was released and returned home in April 1968. NMCB 10's main body was homeported by May.

I rejoined NMCB 23, and remained with them advancing to Petty Officer First Class, then to Chief in 1972, before leaving for overseas civilian work in Saudi Arabia and Colombia between 1977 and 1986. I again rejoined NMCB 23 in May 1990, just in time for Operation Desert Shield/Storm and back to Okinawa with the battalion in support of Seabee operations from Camp Shields!

–Senior Chief Petty Officer Paul Gentner, AIA, CCS, CSI, USNR (Ret.)

A New Era for Air Force Civil Engineers

Early in 1965, there were two occasions where the U.S. Air Force lost a total of 90 fighter bombers due to accidental explosion and enemy mortar attack at Bien Hoa AB in the Republic of Vietnam. HQ Pacific Air Forces in turn requested the use of Prime Base Engineer Emergency Force (BEEF) teams to erect revetments.

Aerospace Defense Command (ADC), Air Training Command (ATC), and Strategic Air Command (SAC) were tapped to provide Prime BEEF teams to deploy to erect aircraft revetments. A collection of officers and senior NCOs met at Eglin AFB, Fla., for mission briefings. It was also brought to mind that the results of this deployment would have far reaching effects on developing the Prime BEEF concept, the Civil Engineering career development, manning and equipment authorizations, and an increase mission capability. This was the first time Civil Engineering troops could demonstrate construction capabilities in a combat zone for the purpose of satisfying an urgent operational requirement that could not be met by other construction agencies. The accomplishments of this deployment could lead to the justification for developing large all-military engineering construction units for the Air Force.

I was on one of these teams.

We arrived in country on Aug. 8, 1965, with ADC (my team) staying at Tan Son Nhut AB, ATC at Bien Hoa AB, and SAC at Da Nang AB. Each team consisted of one officer and 25 enlisted men, plus a three-man survey team.

All three teams, upon reaching the bases and finding no revetment kits to erect, directed maximum effort towards stockpiling fill material and site prepping revetment sites. When the kits did arrive, it became 12 hours a day, seven days a week. The ADC Team erected 4,700-ft of steel bin revetments 5.5-ft wide and 12-ft high, and filled with 11,800-yd^3 of sand. The ATC team erected 3,800-ft of revetments and filled with 9,500-yd^3 of laterite. The SAC team erected 3,540-ft of revetments and filled with 9,850-yd^3 of laterite.

All revetment construction was completed by the teams on Oct. 23, 1965, well ahead of schedule. The teams were then instructed to assist base engineers with construction backlog until their departure in early December 1965.

Prime BEEF 1 was the pace setter; to continue the pace, there were 147 additional teams deployed worldwide between Sept. 15, 1965 and June 7, 1976, for a total of over 4,700 personnel. Today, there are Prime BEEF teams along with units of 400-manned RED HORSE squadrons deployed and providing construction support for the Air Force mission.

For over 50 years, I have been so proud of all my fellow members of Prime BEEF 1 for their accomplishments and devotion to duty and mission. *Aloha.*

–Senior Master Sgt. Bruce Swafford, USAF (Ret.)

We Build, We Fight: The Quarry of Death

Highway 1 was the principal north-south highway in South Vietnam from the extreme south to the Demilitarized Zone. In I Corps, this artery was a major lifeline for logistics support via truck convoys from the major port of Da Nang north to Phu Bai, Quang Tri, Hue, Dong Ha, and eventually Khe Sanh. When I joined Naval Mobile Construction Battalion 9 in October 1967 at Camp Hoover, as the junior Civil Engineer Corps ensign, the base was located near the First Marine Division headquarters outside Da Nang. Highway 1 to the north was a combination of various road surfaces from dirt to asphalt to concrete, and uniformly in terrible shape. It had culverts, some old French bridges, and Bailey bridges—and was the site of almost continuous enemy action in the form of ambushes, mines, and blown bridges.

A key U.S. military engineering objective was to pave this road to make it passable in all weather, reduce the ability of the Viet Cong to mine it, and speed movement of logistics support north. The Marines had placed Combined Action Platoons along the road at numerous villages to protect the bridges with a combination of a rifle squad and village self-defense militia. This tactic proved to be quite effective, if dangerous. In order to pave the road, crushed rock was necessary for asphalt and concrete. Our battalion was tasked with developing a quarry south of the city of Phu Bai with its airfield and support hub, near a village called Phu Loc. This mission started in January 1968, just before the Tet Offensive.

The over 100 Seabees in the detachment, along with the platoon of Marines who were to provide security, quickly found themselves nearly surrounded by the Viet Cong and North Vietnamese forces that had moved south, captured Hue, and engaged in some of the bitterest fighting of the war. It became the site of the heaviest losses of the Seabees in the entire war.

My first visit was a shocker with the reality of establishing quarry operations into a "hill" that we did not "own" was immediately apparent. We were at the bottom. The enemy had troops on the top in well-hidden positions, which I found out soon enough. Just at dusk, they opened on us with a recoilless rifle. The weapon is extremely "personal," since it is direct fire and the enemy is aiming at you as opposed to dropping a round into a mortar tube and hoping it will land with indirect fire. The first round went through the officer and chief tent to right between me and one of the chiefs. It blew us both "up", throwing me through the air some distance. Fortunately, I did not receive a scratch; but unfortunately, it severely wounded the chief I had been talking to. I found myself in the midst of a real-life “war movie,” pulling him into cover and applying the combat bandages from the kit I carried on my web belt along with my pistol and canteen, trying to stem the flow of blood. The attack was fairly brief with my radioman calling in F-4's from Da Nang that covered the hill with napalm. I stopped the bleeding and we moved the chief to the aid station and called in a medevac for all the wounded.

The F-4's had taken care of the enemy position as a Marine patrol reported the next day, but this was the beginning of numerous attacks on the quarry—attacks that now were with mortars and small arms instead of recoilless rifle fire. During a duel with the enemy, a direct hit on our mortar position killed five of the six crew members instantly. For the next four months until our battalion was relieved and a combined U.S. Marine Corps and U.S. Army counterattack crushed the enemy in the area, these attacks continued with casualties to the detachment and to the Marines. But the quarry was opened and the rock crusher put into operation so the paving operations could commence. Largely unheralded and forgotten, this was a costly and vital engineering accomplishment that literally "paved" the way for ensuing Army and Marine combat successes in I Corps.

A little over two years later I returned to I Corps to support the Military Assistance Command, Vietnam – Studies and Observations Group’s Navy special operations component in Da Nang as its engineer and had to drive Highway 1 from Da Nang to Hue. Three things really impressed me. First, I did it in a jeep with one other Seabee on a route that had been secured to the point I was pulled over by Army military police for speeding near where I had been attacked in a convoy two years before. Second, the entire road was now paved and traffic moved easily. And third, the enemy was nowhere to be seen.

The Seabee mission had been accomplished under difficult and dangerous conditions, adding to its proud motto: "We build, We fight!"

–Rear Adm. Mike Shelton, P.E., F.SAME, USN (Ret.)

The Marines Don't Need Architects

At the age of 18 in 1968, looking for adventure, needy of getting away from my small town, and to start my own story, a two-year active, four-year inactive enlistment sounded like the right ticket. And it was.

I put my feet on the footprints in San Diego and became a "Hollywood" Marine. At Camp Pendleton, I learned how to be an Anti-Tank Assaultman, and acquired an 0351 MOS. After a great leave back home, I was flown on a chartered commercial flight to Okinawa with orders to the 3rd Marine Amphibious Force. I was unsure what that might entail. But it didn't matter. Orders changed to 1st Battalion, 5th Marines, Republic of Vietnam.

I had done quite well in art classes in high school and wanted to be an artist. Draw, paint, sculpt: I loved it. While out with my older brother one night he asked me what I wanted to become when I grew up. I told him an artist. He advised that I would not make any money as an artist and should consider architecture where I could earn a living and still practice art. From that moment I saw the future, but it was clouded with adulthood and getting through college. Certainly a university education was out of financial reach.

My first night in Vietnam was spent in a tent at the end of the runway in Da Nang, listening to F-4's roar overhead. The next day found me traveling to An Hoa via a convoy along with other short-haired Marines. As a dozen of us sat on our seabags outside a hooch, a second lieutenant came to the opening and asked who could type. I raised my hand and was invited into the hooch to explain how it was I came to learn to type and what experience I had. I ended up being assigned to the S-1 of the Headquarters Company of the Battalion. Another change of orders.

Sgt. Battle said he would see to it I made sergeant if I would re-up. I told him I wanted to be an architect, to which he replied: "Well, the Marines don't need architects."

The following day I went on a "work party," which meant I was to work alone with the nearby farmers trenching the corner of a rice patty and installing steel culvert. The culvert had "Granite City Steel" printed on it. I had no doubt that it was made by some of my high school friends and their fathers at the Granite City Steel factory, not 10-mi from my house back home. Fond hard memories set in.

An Hoa was a combat base. It was to serve as an anchor to the "Arizona Territory," an exit ramp to the Ho Chi Minh Trail, and a re-supply point for the Marines who humped the bush, which became the assignment of a couple of my boot camp buddies. Both were wounded and sent home. One told me he would rather be in the bush than at An Hoa as we were sitting ducks. To be sure we were. Both An Hoa and the nearby Liberty Bridge were recipients of much attention by the enemy.

One day near the end of my tour, during which Neil Armstrong played golf on the moon and thousands of my generation got soaked at Woodstock, Staff Sgt. Battle (I never knew his first name) asked me to visit him in his bunker that evening. He wanted to talk. I was a corporal, not bad for less than two years active. Sharing his Chivas with me, Staff Sgt. Battle said he would see to it I made sergeant if I would re-up. I told him I wanted to be an architect, to which he replied: "Well, the Marines don't need architects."

Returning home in February of 1970, I started school at the University of Illinois, School of Architecture, using the GI Bill as a recently and happily married student.

I have worked many years now as an architect, primarily on defense projects, and proudly so. Today, I am back in my old small town with my beautiful wife and grandchildren. May God bless those who were less so fortunate.

–Dave McDonough, AIA

A Company, 26th Engineer Battalion, Americal Division

As a combat engineer lieutenant arriving in Vietnam, I assumed I would be directly assigned to an engineer battalion. But the Americal Division had need for Infantry Mortar Platoon Leaders, and many of my fellow engineers were used in that way during their year in country. Luckily, I was hijacked by the S-1, 26th Engineer Battalion and was made Platoon Leader, A Company, 26th Engineer Battalion. The company was in direct support of the 196th Light Infantry Brigade. So the year begins.

The primary mission of A Company was to provide mine clearing for a 10-mi dirt road connecting Landing Zone Baldy and Landing Zone Ross. The road was the primary resupply road for aviation fuel and artillery rounds. Six days a week, two platoons—one from each landing zone—would mine sweep 5-mi of road, meet in the middle and release the resupply convoy, wait until it passed, and then begin the trek back to their start points.

Mine sweeping techniques were less exact in the 1960s than today. We had metal detecting mine detectors that did not find the non-metallic explosives we would encounter, only traditional mines we used in stateside training. Our backup was using a 5-T dump truck as a "pressure testing" device. We would remove the "headache," canvas driver compartment cover and lay the windshield down, then fill the bed with soil, driver compartment and hood with sand bags. The driver would back the truck while sitting on the hood, weaving back and forth to cover as much of the road surface as possible.

When platoons were off the road sweep cycle, we would complete construction activities on the landing zones including constructing the 196th Brigade Tactical Operations Center. Platoons were sent on multiple missions to clear drop zones for the infantry, provide demolition support to an infantry unit after the bombing of an enemy location, perform land clearing operations, and in one case, construct a temporary road into the interior to allow friendlies a path to escape.

For those 23-year-old lieutenants and for those young men we were asked to lead, the year spent together was one of learning about the country, the enemy, and the friendlies—of having people leave and new people come each week. It was at a time when we saw Bob Hope and Ann-Margret, but heard about Broadway Joe's win, Haight-Ashbury, Woodstock, the Landing on the Moon, the Miracle Mets, and I am sure much more.

It was a year that your engineering skills were challenged to determine the size of a culvert to carry "Monsoon flow"; the thickness of fill between the hollow-walled bunker walls to ensure your soldiers were safe from RPG rounds; the strength of native timbers used for simple bridge crossings; the amount of demolitions used to breach different obstacles. But with FM 5-34 in our jungle fatigue pocket, we just looked it up.

–Lt. Col. Wendell "Buddy" Barnes, P.E., F.SAME, USA (Ret.)

"AGENDO GNAVITER"

June 1969 to June 1970 was my second tour in Vietnam. I served in country from 1965 to 1966 as Engineer Battalion Advisor and Group Senior Advisor in II Corps Tactical Zone. On Nov. 3, 1969 I assumed command of the 577th Engineer Battalion (Construction), one of four battalions of the 35th Engineer Group, 18th Engineer Brigade.

The 577th's Don Duong base camp was surrounded by earth berms on three sides with triple concertina wire, and overlooked by a series of guard towers and nestled next to a French-built dam and lake. Headquarters and Headquarters Company, and Alpha and Delta Companies were based there as well as a civilian technical support team for our "yellow iron" 20-T commercial dump trucks and rock crushers. Bravo and Charlie Companies were based at Duc Trong. In May 1970, the 102nd Construction Support Company and D Company, 815th Engineers were attached to develop an industrial site at Di Linh to further enhance road building efforts along QL-20. It was named for Maj. Gen. John A. B. Dillard, USA, who was killed in action heading to Don Duong for an overnight.

Our mission: construct and maintain 144-km of asphaltic concrete national highway and 22 bridges by May 1971 while maintaining our own security as well as providing on-call support to all U.S. units within the battalion area of operations—all 10,500-km^2.

The 577th had paved nothing due to monsoon rains. An industrial site of a batch plant, with 250-TPH and 75-TPH rock crushers was established and the rock quarry was opened. We were to work three major highways— QL 11S (46-km): QL 21B (26-km) and QL 20 (72-km)—and perform survey, design, soils evaluation, earthwork, surface treatment, and vertical construction. Each highway was located in a different terrain type: mountainous with many switchbacks (QL 11); rice patties (QL 21B); and rolling countryside (QL 20). Vertical work consisted of reinforced concrete bridges up to 200-ft in length, timber trestle bridges, rock and mortar retaining walls and multi-barrel corrugated metal piping drainage structures with headwalls. Many undersized culverts were washed out, particularly on Q 11—shot out of the road like torpedoes during the monsoon. The quarry "road" was muddy and a foot or so below ground level due to traffic and heavy rains. Our culvert construction/relocation crews were augmented with local Vietnamese to construct rock retaining walls.

Construction equipment shortages were a continuing 35th Group issue. We had one paving train and a severe shortage of road graders. This necessitated a construction strategy that would best utilize our limited equipment on a given day and highway. We worked six days per week, dawn to dark. We pulled maintenance when crews returned for the day and on Sunday, an off-day after church. We never left equipment on the road. Our maintenance folks were magnificent. They kept equipment up, and part of that success was our logistics expeditor contingent at the Cam Ranh Bay Depot.

The terrain above the Metcalf Industrial Site, named for an operator killed in quarry development, provided a good view of operations as well as trucks hauling rock from the adjacent quarry. We hosted many leaders at the overlook, complete with roof and chairs, where the brigade touted its execution of the Lines of Communication program.

Don Duong was located on the helicopter flight path back and forth from the coast to the highlands. The dam and lake were a scenic location. We built a 20-ft by 20-ft raft and anchored it in the middle of the lake painted with the 18th Brigade patch. On occasion, crews checked their guns on the raft and that caused some local excitement. But our raft never sunk.

In April, we finished the most difficult stretch of roadway the brigade had ever undertaken: the 27-km stretch of QL 11S, the "Good View Pass." This road was transformed from a nightmare to negotiate into worthy of being called a National Highway—"The Good View Pass metamorphosis is one of the Brigade high points in its Lines of Communication Highway Project," it was advertised. We took 18th Brigade Commanding General Brig. Gen. Jack Morris, USA (later Chief of Engineers) on his first Pass ride and surprised him with the General Morris Lookout.

I was blessed with a superb team of engineer soldiers of whom I could not have been more proud. By June 1970, we had finished 37-km on stretches of the three highways and had partially finished another 15-km of our 144-km mission. The accomplishment was the result of determined effort, can-do attitude and plain hard work by each and every man. It was a magnificent performance despite adversity, hostile action, long days and even shorter nights.

The 577th crest is a silver and red shield emblazoned with a gear and shovel and a scroll inscribed *"AGENDO GNAVITER"* in red, translated from the Latin "By Doing Diligently," which we more loosely translated and proudly proclaimed in those days: "Get your ass in gear and start shoveling."

We did.

–Maj. Gen. C. Ernest Edgar III, P.E., F.SAME, F.ASCE, USA (Ret.)

23 February, 1969

At approximately 0030 hours on Feb. 23, 1969, Dau Tieng Base Camp, headquarters of 3rd Brigade came under heavy mortar and rocket fire, followed by ever increasing small arms fire. At 0130 hours, base camp defense alerted D Company, 65th Engineer Battalion, 25th Infantry Division to the fact that the east end of the bunker line had been breached, and could they please respond.

Due to their direct support role to 3rd Brigade, two of the three line platoons were operating out of fire bases. So a portion of 3rd Platoon and Headquarters Platoon mechanics, communications, and equipment operators were available—about 50 men. 3rd Platoon was minus a squad, deployed on a bunker line manning four bunkers, which we defended 24/7. The remaining men were formed into two tactical teams: one around the 3rd Platoon, with 30 men, under Company Commander, Capt. Tad Ono, USA; the second team around the Headquarters Platoon under 1st Sgt. Robert Kennedy, USA.

Capt. Ono's team moved out to the east end of the camp. 1st Sgt. Kennedy's team waited to make sure they did not have to deploy to the bunkers that were being defended on the north side.

Upon determining the four bunkers were not in danger, Team 2 moved to reinforce Capt. Ono, who was engaged at the east end breach. Team 2 crossed the air strip toward the rubber plantation cantonment area. There were five two-story masonry buildings and a large residence structure. The enemy by this time had penetrated into this area and taken the Brigade Tactical Operations Center under light machine gun fire from the second story of the mansion. Returning the fire was a military police unit with a jeep-mounted .50-cal machine gun. This fire was inaccurate and wild, and pinned down Team 2 until they were able via radio to shut them down.

Team 1 had successfully closed the breach on the east end with enemy all around them. However, they held fast and took control of the area, with a loss of three killed in action and six wounded. By 0330, they had control. Team 2, meanwhile, was able to take out the light fire from the plantation house and clear the other remaining buildings one by one. At the plantation house, they found three enemy dead inside and two outside, which were the machine gun crew. They also freed two headquarters personnel who had taken refuge in one of the buildings, a library used by the base camp. By 0430, they were told to hold in place and set up a perimeter defense, despite sniper fire that was eliminated. By dawn, all remained calm. Team 2 had five minor wounds. None required evacuation.

The end results were the main objective of Team 1 was accomplished; the secondary objective, forced by the tactical situation, also was accomplished. Total casualties were three, with 11 wounded. Both teams were released by Base Camp Defense by 1030 hours.

Lt. George Woodin, USA and Spc. Howard Atkin, USA, were awarded the Silver Star for gallantry in action. Several others were awarded the Bronze Star with the 'V' device for heroism.

It is safe to say that the actions of the D Company reaction force prevented the enemy from further penetration through the perimeter bunkerline and were a significant contributing factor in saving the 3rd Brigade Headquarters and the Dau Tieng Base Camp from greater loss of life, as was stated by Maj. Gen. Ellis Williamson, USA, Commanding General, 25th Infantry Division, when he personally awarded the valor awards at a company formation.

–Command Sgt. Maj. Robert G. Kennedy, USA (Ret.), and Col. Tadahiko "Tad" Ono, USA (Ret.)

A Seabee Looks Back

In 1966, a year out of college, I was working at Cape Kennedy in Florida. But I was young, unmarried, and felt drawn to Vietnam—so I volunteered for the U.S. Navy Seabees.

The year 1967 involved training to become a Navy Civil Engineer Corps Seabee officer. In September, I reported to Naval Mobile Construction Battalion (NMCB) 53—homeported at Davisville, R.I.—and was assigned to Alpha Company, the company responsible for operation and maintenance of the battalion's automotive, construction and materials-handling equipment. The Company Commander was Lt. Bill Ivie, USN. The Platoon Chief was Chief Equipment Operator George Sutton, USN. Both were experienced and level-headed, and great mentors to this green ensign. After Vietnam we were good friends.

In January 1968, NMCB 53 arrived in Da Nang and became part of 3rd Marine Amphibious Force. During the 1968 Tet Offensive we were on the defensive perimeter around Marine Air Group 16 and the Naval Support Activity Hospital, both of which were prime Viet Cong targets. What I remember from the 1968 tour was rocket attacks on our camp, and convoys. Convoy experiences included being ambushed; being strung out across a bridge when a truck couldn't get under a concrete arch, and flattening the truck's tires to get us across; and our wrecker getting a hung-up truck off a high French railroad bridge, with the bridge not collapsing. In September 1968, NMCB 53 returned to Davisville.

In March 1969, we were back in Vietnam. Initially, I was Assistant Officer in Charge of a 200-man detachment just below the Demilitarized Zone, with a quarry, rock crushers, and asphalt plant working on critical road upgrades. We had significant problems with augment equipment that wasn't supported though the regular supply system. But mainly I recall trucks and equipment damaged by improvised explosive devices. I then was assigned as Battalion S-2. Finally, I was honored to be Alpha Company Commander. By 1969, we were all tired and some discouraged. I remember being Officer in Charge of the delay party and staying several extra weeks in the combat zone while spotlessly cleaning our retrograding construction equipment to satisfy the Department of Agriculture. As the last of my battalion in country, I hitch-hiked out on a C-141 with 14 from other units: eight of us on canvas seats and seven in aluminum containers. December 1969, NMCB 53 was decommissioned and I was released from active duty.

In looking back, Vietnam Seabee service provided a foundation for the rest of my life. I am especially reminded of our chaplains and long-term resilience provided by the Bible. After Vietnam, I worked at Naval Facilities Engineering Command Naval Civil Engineering Laboratory, then for the U.S. Army Corps of Engineers in Saudi Arabia, Morocco, and Turkey. I also continued in the Navy Reserves, retiring as a commander. I joined SAME in 1967 and around the world over the years have valued Post friendships and the magazine's big picture.

Our battalion has reunions every 18 months. At one reunion, a former squad leader, now a successful businessman, told my wife that I was one of the good ones—the most meaningful compliment I've ever received.

–Cdr. Curtis Anderson, P.E., USNR (Ret.)

In the Mekong Delta

I spent my full tour on the S-3 Staff of the 36th Engineer Battalion (Construction) at Vinh Long Airfield, Mekong Delta, South Vietnam, from January to December 1971. The 36th was under the 34th Engineer Group and the 20th Engineer Brigade. We were later under Engineer Command - Vietnam.

I was placed on the S-3 Staff, as Officer in Charge of Surveyors, Officer in Charge of the Soils Lab, and Officer in Charge of Quality Control. The 36th Engineer Battalion (Construction) was finishing up work on QL-4, around Vinh Long: final asphalt pavement and one prestressed precast beam bridge. The bridge was three spans, each 81-ft long, with 11 concrete 'T' beams weighing 22-T each. I believe we were the only construction battalion in Vietnam to build prestressed precast concrete beam bridges. Other bridges of this type were built by the joint venture, RMK - BRJ (Raymond, Morrison-Knudsen, Brown & Root and Jones). We worked with an adviser of RMK - BRJ.

The battalion was charged with building about 65-km of asphalt road, LTL 7A, from Vinh Long to Tra Vinh, and 22 concrete bridges, some of which also were prestressed precast concrete beam bridges. The beams were built by the Vietnamese in Saigon and barged to us in Vinh Long.

My first mission was to work with the battalion surveyors to make sure the abutments and piers were constructed at the correct location, distance and alignment, because the concrete beams could not be cut to fit the spans. When I arrived at Vinh Long, the 36th had one portable concrete batch plant and one portable asphalt plant at the Vinh Long Army Airfield. It had two rock offloading piers, one near Vinh Long and another about one-quarter the distance to Tra Vinh, near the Bravo Company Base Camp. All our rock was barged to us from north of Saigon because there was none in the Mekong Delta.

As the road progressed from Vinh Long to Tra Vinh, we built Charlie Company Base Camp and rock pier on the Mekong River, near Tra Vinh. The Charlie Company Base Camp would have a portable concrete batch plant and a portable asphalt plant. Our site at the Vinh Long Airfield also got a second portable asphalt plant. As the work got further down the road from Vinh Long, we started running asphalt truck conveys, with Vietnamese drivers in yellow commercial trucks (which we called yellow birds).

We painted a "red seahorse" in the middle of the white stars on our vehicles, and while we were on the road, everyone knew the vehicles with the red seahorses on them were the engineers.

As we finished sections of road, city-size buses and semi-trucks could use the road. We had the road for construction from 0600 to 1800; anyone else had it the other 12 hours. We painted a "red seahorse" in the middle of the white stars on our vehicles, and while we were on the road, everyone knew the vehicles with the red seahorses on them were the engineers. The 36th was the Seahorse Battalion (from World War II and the 36th Engineer Division). I was Mustang 6, Commander of the Battalion Reaction Force.

When the new battalion commander came about midway through the year, I was asked if I would stay on staff as the Assistant S-3, Civil Engineer. I accepted. I had other S-3's coming to see our operation and quality control procedures. The 36th Engineer Battalion (Construction) was a meritorious unit in 1971.

Even though, I am service-connected disabled due to Agent Orange, I would do it again. We dredged all the sand we wanted for construction out of the Mekong River, never thinking it was contaminated with Agent Orange. As a licensed professional engineer, I feel the time in Vietnam was a great experience, and used some of the road stabilization procedure in Kansas in the 1980s, 1990s and 2000s.

–J Neil (Stevens) Jednoralski, P.E.

On Yankee Station

I graduated from college with an engineering degree in 1969 near the height of the Vietnam War.

A few months later, in October 1970, I joined the Navy Supply Corps and completed Officer Candidate School at Newport R.I., and was subsequently posted to the Supply Corps School in Athens, Ga. In those days, the Supply Corps was looking for engineers and I wanted a commission. I was detailed to the USS *Kansas City*, operating on what was called Yankee Station off the coast of Vietnam. She was relatively new at the time, having been launched in 1969.

Our normal operation consisted of taking dry stores, munitions, and fuel from the slow, older supply ships and oilers in the daytime and transferring it to the aircraft carriers at night. It wasn't terribly dangerous, but an incredible amount of work because we were basically working all day and night. I started as the Disbursing Officer and was subsequently promoted to a combination of Ship Services Officer and Food Service Officer. Because I had the mess cooks in my division, I never missed a Captain's Mast.

Other than a couple of small collisions (in those days, the captains of auxiliary ships were usually aviators who had to spend time commanding a ship before they could be promoted to flag officer and seldom had any experience at all in ships), the most interesting thing that happened was that the fork truck drivers managed to drop a 2,000-lb bomb down the ship's freight elevator. I was in my office at the time and only heard a giant thud. But the ratings who did it and knew what was happening were really scared for a few seconds. It had not, of course, been armed and the only damage was that it dented the floor of the elevator. The captain was not pleased!

I was glad to be in the supply office. The officer on board with the accounting degree was in the engineering department and his office was always about 105°. The one brush with real engineering while I was on board was when there was a refrigerant leak (the *Kansas City* had refrigerated spaces the size of small houses) and they wanted to know if there was a danger. It was in the engine room, though, and immediately went into the engine intake air and never bothered anyone.

After the war, I went back to being an engineer full time, and I now have a small business manufacturing oil water separators. Last year, I was glad to be able to provide new equipment to the naval facility in Bremerton, Wash., and also to the new hangar for the V-22 Osprey base at Marine Corps Air Station New River, N.C. I had previously provided similar equipment for the Marine base at Camp Pendleton and other military facilities.

I have always been proud of my time in the Navy. I am still ready for sea, but not likely go again anytime soon.

–Kirby Mohr, P.E.

The Ho Chi Minh Trail

I was the Commander of Company C of the 4th Engineer Battalion, which was in direct support of the 2nd Brigade of the 4th Infantry Division. It was my company that had the principal responsibility for the obstacles placed on the Ho Chi Minh Trail. One of those obstacles we built was an abatis, and quite probably the only one constructed in Vietnam.

At one point in 1968, two platoons were inserted between the north and south operations. The reason why is pretty unique. What happened was the first platoon to go in was in direct support of an Infantry Battalion providing security for a 105-mm battery and a reaction force. Because the troops on the trail were taking longer than expected, the decision was made to insert another platoon.

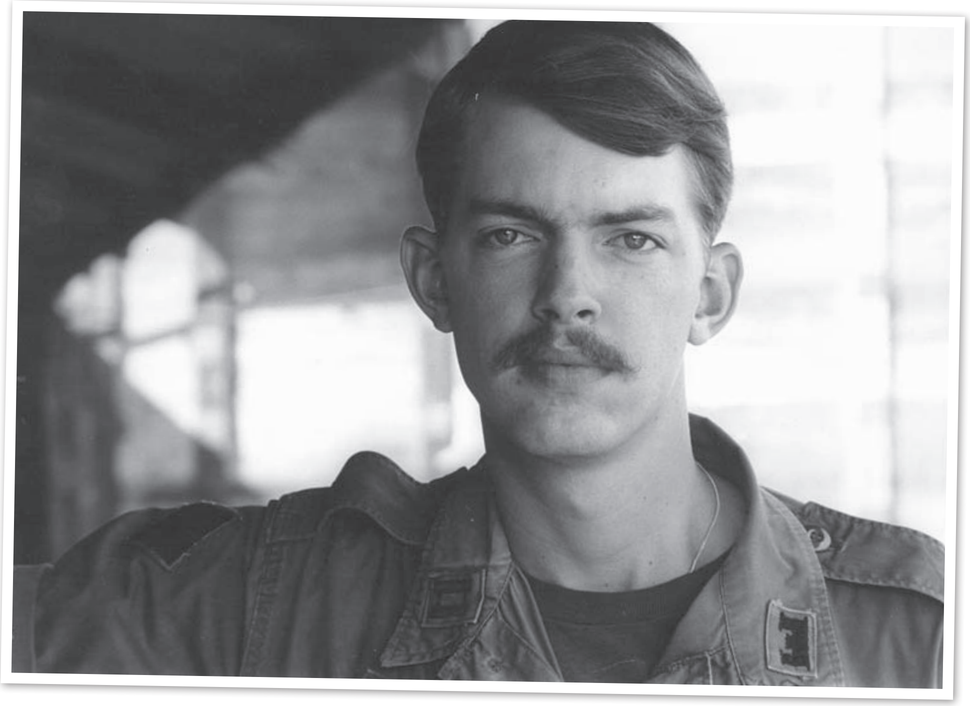
A problem had developed, though, before the platoon was inserted in that the platoon had a puppy. My platoon leader had called me and told me that the artillery had a dog that was diagnosed with rabies, but that the puppy was too young to have a rabies vaccine. His question was, what should he do.

I talked to the brigade surgeon who said they had to send the body of the puppy back for testing. This was done and the results confirmed that the puppy also had rabies. While the puppy had not bitten anyone, the men had nicks and cuts from clearing fields of fire and building bunkers. The puppy had licked their hands. The surgeon told me that a board of three doctors needed to interview the men and two of the three had to agree that the men needed the series of 15 rabies shots. By this time the platoon had been inserted onto the Ho Chi Minh Trail. I told the surgeon that I needed a board of doctors to go with me to the Ho Chi Minh Trail and interview the members of the platoon. I ended up with two doctors who went with me and landed on the trail and interviewed the men of the platoon. All but my platoon leader had to receive the 15 rabies shots.

As a result, I had to replace that platoon with another platoon so they could receive the rabies shots. My platoon leader told me afterwards that he did not think he had any contact with the puppy and he sweated out the incubation period.

–Maj. Brian Ashbaugh, F.SAME, USAR (Ret.)

Military Region IV: "The Delta"



During 1971, I served as a member of the 34th Engineer Group located in Binh Thuy, South Vietnam. The primary mission of the group was road and bridge building throughout Military Region IV. We had four engineer construction battalions assigned to the group: the 34th, 36th, 69th and 92nd. The group also had several separate companies assigned to it, such as a port construction company that provided much of the pile driving operations for bridges and abutments.

Military Region IV was known as "The Delta" since major portions of the region were used to cultivate rice patties, a major crop for local nationals. The region posed many significant challenges for road and bridge construction, and for constructing base camps. The Mekong River was the major tributary. Many of the base camps used for company sites along the river and road routes where constructed on sand dredged from its sandy bottom. The four battalions each had a segment of road they were responsible for. The 34th was located in Chau Doc, near the Cambodian Border. Its mission was to construct a highway and bridges moving southeast along the QL towards Can Tho. The 92nd Engineer Battalion, located in Binh Thuy, was responsible for construction moving northwest on the QL to link up with the 34th. The 69th was located in Can Tho and provided horizontal construction activities moving south along another QL. The 36th, headquartered in Vinh Long, constructed southeast on QL to Tra Vinh. Each battalion had at least one company operating independently and camped along the routes. Each also had one or two portable asphalt batch plants along the route. At times during the year these plants had to be relocated to make the production more achievable.

Materials were a major resource constraint. All stone materials had to come by barge from the rock quarry on Vung Tau, Military Region III. Managing the tug boat assignments moving the rock/materials up and down the rivers and ensuring the right barge was delivered to the right site on time proved a huge logistical challenge. Having the right materials at the right place at the right time was critical. The group had an officer in the S-3 section who devoted his full time to managing what aggregate resources needed to be where at the proper time to keep productivity of activities to the maximum output possible.

An individual affectionately known as the "Rock Officer" would present the locations of all barges and types of resources loaded and the days on hand that each battalion had at the offload sights as well as intermediate mooring sites/buoys. On many occasions, the Rock Officer had to rely on message traffic from the quarry and tug captains to present the most current information. During one morning briefing, as the Rock Officer completed his presentation to the group commander and staff, the commander responded that he did not have a clue where the barges were since he had just flown over all the rivers and off load sites the afternoon before and the information just presented to him did not match with his visual observations. The commanding officer turned to me. I was the Assistant S-3 and was responsible for the management of the group organic aviation assets. He said to schedule a chopper flight that afternoon for the Rock Officer to fly to the Vung Tau Rock Quarry, board the first departing barge of aggregate—not the tug—and ride the barge to its final destination while observing and noting the obstacles to the prompt delivery of these precious resources. The officer departed with his M-16, ammunition, steel pot, flak jacket, and a case of C-rations.

After a number of days, the Rock Officer returned to brief the Group Commander and staff. Unshaven, no shower, still dressed in his combat gear, he presented what he learned about river resource management operations. He gave a very detailed report that proved very accurate and addressed a number of issues that only an on-the-ground assessment, so to speak, can provide. The lasting lesson: first-hand observations are critical to successful operations.

I served in Vietnam as a young captain and learned many lessons with regard to operations in difficult terrain. Two officers I learned great lessons from were Maj. John Knutzen, USA, the Group S-3 and Maj. John Helmlinger, USA, the Group S-4. Their mentorship during my early Army experience provided me with the foundation of my 30-year career. They were both true American heroes and I will never forget them. May they rest in peace.

–Col. Jeffrey Wagonhurst, F.SAME, USA (Ret.)

On the Front Lines

After proudly graduating in the summer of 1966 with a degree in Civil Engineering, I immediately went to work on several options for getting the "dreaded" military obligation out of the way so I could get on with the more affluent lifestyle I had always dreamed about.

At the time, I was certainly aware of the ongoing conflict in Vietnam, but always thought of it as far away and someone else's problem. I never contemplated the possibility that I would be drafted and if so, that I would be assigned to the infantry. I looked into Officer Candidate School options (in other than the U.S. Army), but the application processes dragged on and it didn't look very promising for selection. After several letters to the local Draft Board, I was granted one short extension. However, after that, when none of the other options appeared to be working out, the Draft Board prevailed and I was inducted into the Army on April 12, 1967.

After the initial shock of being drafted wore off, it didn't seem quite so dreadful. It was only a two-year obligation and I just wanted to get it out of the way as quickly and easily as possible. I still believed that there was some good news in that a college graduate and a skinny kid would never be someone they would pick for the infantry.

I was shipped to Basic Training in Fort Polk, Louisiana, which was bad news in itself, both from a mental and physical standpoint. Although, as the initial eight weeks of basic training was winding down, I was somewhat pleased that the end was in sight and I had been able to keep up and compete on a par with everyone else. I had survived Basic and thought that the combat style training would be over. However, the feeling was short lived. The bad news came back quickly.

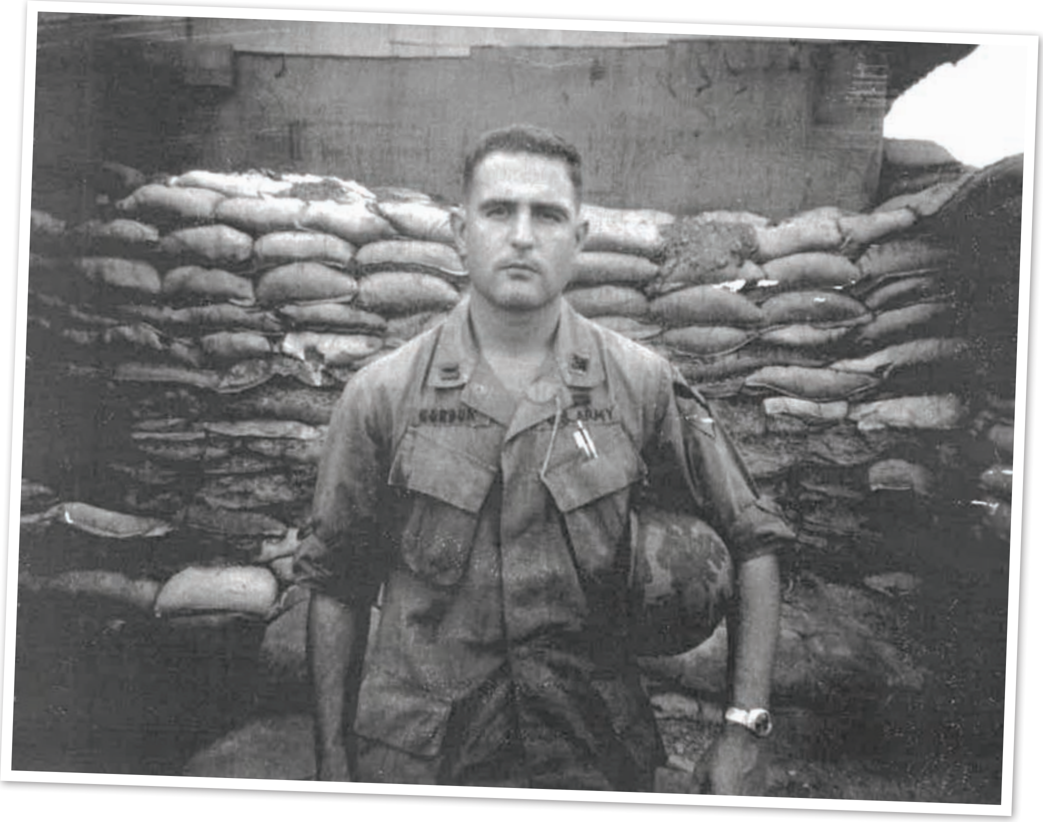
On the last day of basic training they announced everyone's next assignment. I learned, along with many of the others, that we were looking at eight weeks of Advanced Infantry Training. More weapons training, lots of physical conditioning, obstacle courses, night training, lots of abuse and harassment thrown in for good measure, live-fire courses, grenade and small rocket training, emergency medical field procedures—all the obvious things needed to prepare soldiers for a combat assignment. Everybody in this group knew the front lines in Vietnam would be our next stop.

The first firefight I remember was an ambush that we walked into and I was amazed at how quickly my adrenalin kicked in and how anxious I was to fight back. However, I was a ways back in the formation from the initial contact point and had to sit tight for a while, which I remember as being extremely difficult. Nobody likes being shot at and then having to lay there wondering what's going on and what we might be called on to do next. I had been in country less than a month and wondered if this was going to be how it all would end for me.

Our battalion was called the "Manchu's" and consisted of four companies, Alpha, Bravo, Charlie and Delta. We were Bravo, 2nd Platoon and I was in the 3rd Squadron. I learned to like and trust most of those in my group. Bravo Company always seemed to be better prepared and in general took fewer casualties than did Alpha, Charlie and Delta. This could have been just luck, but our Company Commander, Capt. Al Baker, USA, probably deserves most of the credit.

I survived the war but that is only part of the battle. Some of the combat survival skills I learned, both good and bad, have stuck with me. A heightened sense of awareness is always there and I'm always on the lookout for danger. Mental scars remain and learning to recognize and deal with them on a daily basis is still part of my life.

–Thomas Smith, P.E., GE



The Bomb

I served in Vietnam as an Airborne Ranger with the 1st Air Cavalry Division from 1969 to 1970.

I was attached to several Special Forces 10-man A-Teams on special operations. About halfway through my tour, I was promoted to captain and, shortly thereafter, became the Battalion's Operations Officer (S-3), normally a major's slot. Our previous S-3 had been killed and until his replacement could get in country, it was my job.

As a Platoon Leader, for the first six months of my tour in Vietnam, I was heavily involved in combat operations. Serving as the S-3, my normal day would start about 3:00 a.m. But, long about midday, things were pretty quiet and I could catch up on sleep.

One day we received a radio call from the S-3 at the 75th Ranger Battalion, also located at our base camp in Pluc Vinh. The Rangers needed help from a demolitions expert. One of their Long-Range Reconnaissance Patrol (LRRP) teams found what looked like a bomb and they were considering standing 50-ft away and throwing frags at it. When they told me what action they were considering, I went nuts. I knew that what they were about to toss frags at was a 10,000-lb bomb that we dropped from C-130s by parachute to create a landing zone. I told the S-3 that if they threw frags at it, they would be vaporized. I grabbed a sergeant who was also Ranger-qualified and the two of us, with our rappelling ropes, weapons and demolitions, were picked up by a Ranger Slick accompanied by a Cobra Gunship.

We flew to the extreme west end of our area of operations, adjacent to Cambodia. Our Slick hovered directly over the LRRP about 100-ft off the ground. The triple canopy jungle made it difficult to rappel through. The bomb had been placed on dollies by the North Vietnamese Army. The LRRP must have interrupted their efforts.

The sergeant team leader looked at me and said "Geez, I didn't realize they were going to send a captain out here." I responded that I didn't have too much to do during the day so I thought I would come and help you guys out. In the meantime, the Cobra and our chopper were circling and we were in radio contact. The pilot said there was a potential extraction landing zone about one-half mile from us, but that the North Vietnamese might be waiting for us. The bomb, when detonated, would vaporize everything in the area. We were going to have to run through the jungle to get to the landing zone. We popped smoke every couple hundred meters so the pilots knew where we were. Our plan was to reach the clearing at the exact same time.

Everything worked like clockwork. We hit the clearing, jumped in both sides of the Huey, and got out of there fast. We were all looking back waiting for the bomb to go off. Fortunately, we had dual primed the bomb because the last thing we wanted was to go back and reset the charges. Within about five minutes, the bomb went off. It looked like an atomic bomb. I turned to the LRRP team leader, and he looked at me with his eyes as wide as saucers. All he could say was "thank you, thank you."

That was just one of many interesting stories from my combat experiences in Vietnam.

–William H. Gordon IV, P.E.

35th Combat Engineer Battalion

I served two tours in Vietnam.

As a captain, from July 1964 to July 1965, I served as the Military Assistance Command, Vietnam Topographic Advisor. There were only two topographic organizations in South Vietnam. The first was the Service Geographique National in Dalat and the second was an Army of Vietnam Topographic (Topo) Company, which was identical in organization to a U.S. Army Topo Company. The company was located at Go Vap, close to Tan Son Nhut Air Base.

When I first arrived, I felt quite inadequate since all the officers and most of the sergeants in Topo Company had been to school at Fort Belvoir and everyone at the National Geographic Service had been trained by the French. They all were excellent map makers—most forgot more in one good night's sleep than I will ever know. As a result, I served more as an expediter than advisor. I worked with Army Map Service Far East in Japan to make sure both organizations had the necessary equipment and reproducibles to keep their maps updated. I was provided a good camera and Master Sgt. Westerman and I spent many days at the Minister of Interior, photographing plans for roads, bridges, ports and airfields. These later became valuable as U.S. Forces increased.

I returned to Vietnam in June 1969 as a lieutenant colonel to command the 35th Combat Engineer Battalion. Commanding the 35th was a great privilege. I had the best sergeant major in the Army, Sgt. Maj. James Torres, and the best Executive Officer, Maj. Bob Stuart. The battalion had many fine officers and soldiers. Because we had numerous tasks, troop morale was high with very few disciplinary problems.

During my tour, the battalion was assigned to the 36th Group of the 20th Engineer Brigade, with a primary mission of widening and improving National Highway 4 (QL 4) between Can Tho and Soc Trang in the Delta. The battalion had four line companies, Headquarters Company, and the 517th Light Equipment Company. Companies A and D were stationed at Soc Trang and Headquarters Company, the 517th, and Companies B and C were stationed west of Can Tho on a dredged sand fill between Can Tho and Bin Thuy AFB. Until December 1969, the battalion was supported by an ordnance detachment that enabled us to keep our vehicles and equipment running. However, that support was pulled as part of the overall drawdown, and our deadline rate skyrocketed. I'm sure it was the highest in the Pacific Theater from January to June 1970. We were at the end of the supply line, and with no Third Shop support it was difficult to get parts or timely major repairs.

The initial work on QL 4 was to improve the existing road and pave it using a double bituminous surface treatment. The companies at Soc Trang worked to the north while those at Bin Thuy worked to the south with the objective to meet at Phung Hiep, roughly halfway between the unit base camps. Phung Hiep was at the junction of several canals, and close to a branch of the Mekong River. The 35th had established a barge offloading site near Phung Hiep, where we docked the rock barges that brought gravel for the project. The plans worked well and the battalion was able to improve the full 55-km of road by the end of October 1969.

Then we received orders to widen the road to 24-ft with 6-ft shoulders. This task was a stretch for a combat engineer battalion. The construction battalions of our parent unit, the 36th Group, used their large capacity earth movers and a soil-cement process for such work.

Along with widening and paving the road, we had to bridge major water crossings. With the help of Lines of Communication advisors, we constructed seven 75-ft steel bridges. Construction entailed driving pile foundations and sheet pile headwalls, then welding the steel beams to achieve the required length. Our battalion welder from the motor pool got quite a work out, and the unit crane operators became very proficient at driving piles.

While QL 4 was the primary mission, we received orders for several other interesting jobs. We built air strips throughout the Delta, everything from a sod strip for the Special Forces Camp at Ha Tien (the westernmost point of Vietnam) to an experimental aluminum mat airfield at Moc Hoa. We also built a prison at Soc Trang. The airstrip at Moc Hoa was used heavily during the incursion into Cambodia in the spring of 1970.

When the 9th Infantry Division was pulled out of Vietnam in 1969, the 35th Combat Engineer Battalion was left as one of the southernmost U.S. ground combat units in country. Everyone lived in general purpose medium tents and the only wood buildings were the mess halls. Burn-out latrines were the norm and showers were jury-rigged 55-gal drums. However, thanks to some very talented officers, a great sergeant major, and a terrific NCO chain of command, morale remained high and we were able to accomplish all assigned missions.

–Maj. Gen. James W. Ray, F.SAME, USA (Ret.)

Bong Son Bridge

In late 1969, the QL 1 bridges crossing the Song Lai Giang River, located some 50-mi north of Qui Nhon near the city of Bong Son, were presenting major traffic congestion problems with the flow of supplies to Landing Zone English and points north. A new dual-lane bridge was needed to cross the 1,600-ft-wide river.

The 84th Engineer Battalion was tasked with building the new bridge and before the fall monsoon season of 1970. The battalion formed an engineer task force consisting of B Company and the 536th Port Construction Detachment, and reinforced it as needed with an array of resources such as additional welders, crane operators, as well as civilian engineering consultants. I assumed command of B Company and was the onsite project manager from December 1969 through August 1970.

B company moved from south of Qui Nhon into a coconut grove on the south bank of the Song Lai Giang River in mid-December 1969. We established a cantonment area, equipment park and industrial site during the monsoon rains—mobilizing the entire effort amidst a sea of mud. We developed those areas that would dry out first into production facilities for components that would take the longest to produce. Although the initial plans were to remove several coconut trees to clear the way for tropical wooden buildings, many buildings were redesigned to avoid damaging trees. In a few cases, the trees actually protruded through the overhangs of the tin roofs. Local villagers were pleased that we avoided economic damage to their harvest. We watched as they climbed those trees and harvested coconuts. We used D-7 dozers to build a protective coffer dam upstream site using sand from the river bottom. We built a construction causeway to provide access for construction equipment to drive pile, erect steel, and construct concrete caps atop the piles. The first pile was driven on Jan. 22, 1970.

The overall project consisted of several integrated phases: steel pile driving, deck slab production, concrete cap construction, stringer splicing, stringer installation, deck slab, curb, handrail, lighting and grouting installation, and roadway paving. We encountered myriad challenges, including equipment breakdowns, enemy activity, weather delays, unanticipated changes in the river hydraulics, and last minute increases in scope details. In spite of all this—and in less than eight months after the first pile was driven—the new bridge was passing traffic and turned over to the Vietnamese Government in September 1970. The bridge was 1,634-ft long, with a 24-ft wide roadway, with two abutments, 26 piers, 27 spans, and two approach roads. It was the longest permanent bridge built by American troops in Vietnam.

In May 2016, I revisited the bridge site with several former members of the 84th. Although the decking of the original bridge has been replaced, the substructure remains in place as built—with the exception of two spans that were subsequently dropped by enemy action and restored. The bridge is in good shape and passing traffic. The cantonment area and industrial park is completely gone, overgrown with trees and vegetation.

–Col. Roger Baldwin, P.E., F.SAME, USA (Ret.)

Far From Any Flagpole

People occasionally ask me, "What was Vietnam really like?" And I always reply, "I haven't got a clue."

You see, almost everybody's experience was different—just like the old tale about four blind men who encountered an elephant and described it as four different animals. For example, I was one very old combat engineer lieutenant, having graduated, married, and been working in a career job several years before I held up my right hand and swore to "support and defend the Constitution of the United States against all enemies, foreign and domestic." And none of my guys were typical soldiers, as we served in a Non-Divisional, Provisional Unit. Don't expect anyone to know what that is. But suffice it to say, we all were assigned to another unit then detailed to that one.

As you might suspect, the men provided to us would never be asked to model for a recruiting poster. In point of fact, a fair number were not sent to the Army by their local Selective Service Board, but by a judge who offered them a choice between the Army and what he had in mind. Despite what you might think, to a man, all made exceptional soldiers. Not the most agreeable people you might meet, but no job was ever too difficult nor too dangerous. It was my honor to serve with them.

My guys and I worked far from any flagpole, never saw an air conditioner or even plumbing, and for the most part slept on dirt and ate out of a can. It was true Military Engineering as we worked closely with the soldiers we supported. We did all the regular combat engineer work and for a while seemed to specialize in field fortifications. This was due to the command emphasis on the establishment of remote fire bases to provide overlapping umbrellas of artillery coverage. Unfortunately, it placed individual artillery batteries at risk as they were apparently not trained to defend themselves—generally constructed fences anyone could walk through and bunkers that would fall down of their own accord.

There was no problem obtaining the barrier material (such as barbed wire and steel posts), but dimension lumber necessary to reinforce bunkers was in very short supply. We assumed it was going to the construction battalions for base camp improvements. So we just filled sandbags while waiting for the lumber and timbers to become available.

Despite what you might think, to a man, all made exceptional soldiers. Not the most agreeable people you might meet, but no job was ever too difficult nor too dangerous. It was my honor to serve with them.

Then I got hit with a blinding flash of brilliance. I got my first degree in Forest Management and just beyond our wire was all the wood that was required. We started logging! After all, the issue was expediency not permanence. My boss commended me for the initiative, but no good deed ever goes unpunished. A South Vietnamese politician claimed ownership and demanded compensation…excessive compensation. Then I was "requested and required" to go to town and meet with the aggrieved party and a State Department representative in order to arrive at a fair and equitable settlement. Guess an on-site meeting was out of the question. I provided a volume estimate of the timber taken and everyone seemed to agree.

I thought the meeting had gone very well until I read the State Department guy's report. Essentially, he said: "We were at loggerheads until Whitley got there, took off his flack jacket, and laid his 12-gauge shotgun on the table."

–Marvin Whitley

God, Send the Engineers!

Although time dulls some memories, others are as vivid as yesterday. The most vivid are those during the Tet Offensive: 1968.

While in Vietnam, I served as Delta Company Commander and S-3 Operations Officer of the 4th Combat Engineer Battalion, 4th Infantry Division. Lt. Col. Vald Heiberg, USA (later Chief of Engineers) was my commander. Our Central Highlands area of operations was staggering—about one-third the size of the state of Alabama, all because of the mobility provided by the UH-1 Huey, OH-6 Cayuse, CH-47 Chinooks, and CH-54 Skycranes. On the ground, we had two M48 tanks, a Rome plow, and a tank mounted mine roller.

Our missions were varied. In early 1968 our "sappers" fought as infantry, rescuing two Republic of Vietnam Army platoons trapped in a schoolhouse in Pleiku, killing 21 from the North Vietnamese Army and capturing 10 more. Through the year, we conducted Search and Clear Operations in the "no-man's lands" outside villages and Cordon and Search operations. Demolition missions included bunker and tunnel destruction. The largest bunker complex we found had 260 bunkers. Normally we made tunnels or bunkers uninhabitable with a combination of demolitions and tear gas.

Mine clearing included hand-held sweeps and mine roller operations along main supply routes. On several occasions we conducted missions to relieve infantry units caught in old French anti-personnel minefields. Using demolitions and chain saws, we cut landing zones, then expanded them into 60 fire bases that year.

As that fabled World War II poem written by an unknown combat engineer says, "When the going is really rough…God, send the Engineers!"

While the missions recount what the company did, it is the sappers of Delta Company who are the real story. As that fabled World War II poem written by an unknown combat engineer says, "When the going is really rough…God, send the Engineers!"

They went, they completed every mission thrown at them, and lived up to the "Essayons" motto.

Several rappelling platoon stories come to mind. As leader of that platoon, Lt. Charlie Friend, USA, led many insertions into heavily wooded mountain tops to cut two-ship landing zones for infantry combat assaults. On one occasion, a squad was clearing a landing zone when they were attacked with B40 rocket and automatic weapons. Two Huey's loaded with "grunts" were hit by enemy fire and crashed. The heroic action of Spc. David Brown in eliminating an enemy position while rescuing a wounded grunt resulted in his being awarded the Silver Star. In another action, Lt. Friend's platoon was inserted to extract 27 bodies from the wreckage of a downed C-47 near Ban Me Thout. When a Huey "snoopy" crashed on the Cambodian border into a ravine, Charlie and Spc. Lee Dozier were inserted. There were no survivors and the classified equipment had been destroyed. They popped red smoke to signal a "hot" landing zone. Our Huey lowered two ropes, they tied off, and we climbed to 3,000-ft to get out of effective small arms range. When we landed to recover them, they couldn't let go of the ropes. I cut the ropes so they could come aboard.

The leadership and initiative of troops like Charlie Friend, David Brown, Lee Dozier, Platoon Sgt. Sterling McClard, Pvt. 1st Class Anthony David and so many more remain as a legacy of honor and sacrifice. Their stories are the real ones: what they did, what they saw, and how they dealt with it when they returned home are a source of both pride and quiet suffering from situations that were too real for others to understand. Too many were exposed to circumstances that shook their moral conscience. Yet they prevailed.

–Col. Stretch Dunn, USA (Ret.)

SAME in Southeast Asia

Throughout the 1960s and early 1970s, as military engineers and industry partners located to Southeast Asia to support the Vietnam War, SAME provided a venue for sharing insights, addressing challenges, reviewing lessons learned and staying informed of engineering issues transpiring outside the war. The Saigon, Cam Ranh Bay, Siam and Da Nang Posts along with others in the region offered SAME members a way to get connected "over there."

SAME Posts Map, 1967

SAIGON

"Project Turnkey" was the subject of a talk given at the December 15 meeting by Col. Archie S. Mayes, director of civil engineering, Headquarters, Seventh Air Force. This project involved the construction of the air base at Tuy Hoa, Vietnam.

SAIGON

At the February 14 luncheon meeting Lt. Gen. William F. Cassidy, Chief of Engineers, reviewed the engineering projects which have been completed in Vietnam since the arrival of the American engineers. One example which he cited was the evolution of Cam Ranh Bay from a small coastal port into the largest logistic complex in Vietnam, with a deep-water port, large supply and maintenance facilities, and an airfield. General Cassidy also emphasized the importance of the extensive construction program in the United States in support of the war in Vietnam.

SAIGON

The activities of the Naval construction battalions and civic action teams working in Vietnam and their possible influence on the future technology of South Vietnam were described at the April meeting by Rear Adm. Paul E. Seufer, officer in charge of construction and commander of the Seabees in South Vietnam.

SAIGON—Members of the Post. Eighty-nine percent of all eligible officers of the "Screaming Eagles," 326th Engineer Battalion, 101st Airborne Division (Airmobile), are members of The Society. Shown here are 35 of the 39 members. L to r: 1st row: Lieutenants McCaslin, French, and Ozimek; Captains Collins, Smith, Green, Fisher, Dobrzanski, Herndon, and Bousquet; and Lieutenants Jenkins, Sevier, and Jones. 2nd row: Lieutenants Kraucunas, Ridenour, Lalli, Schaeffer, Sadoff, Balog, Stewart, Malguarnera, Topolski, Rio, Gange, and Fritz. 3rd row: Captains Mentell, Howard, and O'Halloran; Major Hughes; Colonel Rodolph; Majors Lee and Schneebeck; and Captains Hartsook, Bergstrom, and Webb.

DA NANG—Officers of this new post are shown with the speaker at the December meeting. L to r: Capt. H. H. Norman; Rear Adm. J. G. Dillon, the speaker; Comdr. M. J. MacDonald, who presided over the meeting; V. L. Petersen; and TSgt. J. Menditto.

DA NANG

The officers of this newly organized post are Lt. Col. Joseph R. Gayhart, Jr., president; Vernon L. Petersen, secretary; TSgt. James Menditto, treasurer; and Capt. Henry N. Norman, assistant secretary-treasurer.

The speaker at the December 7 meeting, which was attended by 57 persons, was Rear Adm. John G. Dillon, commander of Naval Construction Battalion THREE. Before describing the responsibilities and accomplishments of the Seabees in the I Corps area, Admiral Dillon praised the spirit of co-operation between the various branches of the American Armed Forces in Southeast Asia and pointed out the role the post could play in enhancing this spirit.

DA NANG

The mission, problems, and effectiveness of Marine Corps reconnaissance patrols in the I Corps were discussed at the June 7 meeting by Maj. Bill Bond of the 1st Marine Division.

At the July 5 meeting, a certificate of appreciation was presented to the Da Nang Armed Forces Radio and Television Station for its assistance in organizing the Da Nang Post. New officers elected at the meeting are Col. Roscoe A. Barber, president; Harry A. Peppler, Jr., secretary; Lt. David C. Harmon, treasurer; and Lt. Col. Robert R. Hering, director.

SIAM

There were 145 members and guests at the meeting on January 24 to hear Rear Adm. Paul E. Seufer, deputy commander of the Pacific Division, Naval Facilities Engineering Command, describe the construction being done by the Seabees in Vietnam.

New officers were elected at the February 21 meeting: Capt. Wayne J. Christensen, president; Col. Gus J. Pappas, vice president; Maj. Franklin O. Mikle, secretary; Lt. Comdr. William V. Sayner, Jr., treasurer; Capt. Joseph P. Parimucha, assistant secretary-treasurer; Capt. William M. Gustafson, Howard G. Dixon, Jr., and John E. Cobb, directors. Special guests at the meeting were Maj. Gen. Richard G. Stilwell and Maj. Gen. Thomas J. Hayes. General Stilwell presented the Charter to Captain Christensen and was elected an honorary member of the post.

SIAM—The Charter of this newly organized post was presented to Capt. Wayne J. Christensen, the post president, on February 21 by Maj. Gen Richard G. Stilwell and Maj. Gen. Thomas J. Hayes.

CAM RANH BAY—At the November meeting (l to r): Brig. Gen. Archie S. Mayes, Maj. Gen. Robert H. Curtin, Brig. Gen. Willard Roper, Capt. George Yount, and Col. Harold J. St. Clair.

SIAM

The Advanced Research Projects Agency—its function and some of its accomplishments—was the subject of a talk at the October 28 meeting by Col. G. S. Akerland.

New officers are Col. Benjamin W. Davis, president; Capt. E. G. Underhill, 1st vice president; Col. Alfred L. Griebling, 2nd vice president; John T. Corson, secretary; Leo A. Maskaliunas, treasurer; and Capt. Jeffrey M. Arey, assistant secretary-treasurer.

CAM RANH BAY

The June meeting was held at the Vinnel Corporation's land base plant. After a brief tour and orientation of the transformer station, the 50 attending members were taken on a tour of a power ship by Robert E. Ames, assistant project manager of marine operations at Vinnell.

About 70 members attended the July meeting which was held at the headquarters of the 18th Engineer Brigade. They were briefed on the organization of the Brigade and various aspects of its operations by Col. Harold J. St. Clair, the deputy commander.

CAM RANH BAY

Maj. Gen. Robert H. Curtin, Director of Civil Engineering, gave an illustrated talk on Antarctica at the November 12 meeting which was attended by 85 persons.

At the December 22 meeting, Brig. Gen. Willard Roper, commander of the 18th Engineer Brigade, presented a program on "The Markland Lock and Dam Accident."

CAM RANH BAY

At the December luncheon meeting, Richard H. Rose of the RMK-BRJ construction combine presented a film on "RMK-BRJ Construction in Vietnam."

The speaker at the February 2 meeting, which was attended by 75 persons, was Robert Ames, marine operations manager for the Vinnell Corporation. In his talk on "Project Power Float," he described the refitting of former fuel tankers from the active Navy fleet and some from the reserve fleet into power-generating ships that service many of the major installations in Vietnam. This subject was of particular interest to post members because their electricity is supplied by three of these converted ships.

New officers are Col. John S. Egbert, president; Comdr. Robert L. Jones, vice president; Capt. Mark D. Malkasian, secretary; Capt. Birney Pease, treasurer; and Lt. Robert R. Haringa, director.

Society of American Military Engineers

Engineer Medal of Honor Recipients from the Vietnam War

Pfc. Jimmy W. Phipps, USMC

Company B, 1st Engineer Battalion, 1st Marine Division
Near An Hoa, Republic of Vietnam, May 27, 1969
Killed in Action

For conspicuous gallantry and intrepidity at the risk of his life above and beyond the call of duty while serving as a combat engineer with Company B in connection with combat operations against the enemy. Pfc. Phipps was a member of a 2-man combat engineer demolition team assigned to locate and destroy enemy artillery ordnance and concealed firing devices. After he had expended all of his explosives and blasting caps, Pfc. Phipps discovered a 175mm high explosive artillery round in a rice paddy. Suspecting that the enemy had attached the artillery round to a secondary explosive device, he warned other marines in the area to move to covered positions and prepared to destroy the round with a hand grenade. As he was attaching the hand grenade to a stake beside the artillery round, the fuse of the enemy's secondary explosive device ignited. Realizing that his assistant and the platoon commander were both within a few meters of him and that the imminent explosion could kill all 3 men, Pfc. Phipps grasped the hand grenade to his chest and dived forward to cover the enemy's explosive and the artillery round with his body, thereby shielding his companions from the detonation while absorbing the full and tremendous impact with his body. Pfc. Phipps' indomitable courage, inspiring initiative, and selfless devotion to duty saved the lives of 2 marines and upheld the highest traditions of the Marine Corps and the U.S. Naval Service. He gallantly gave his life for his country.

All citations are published in full.

Cpl. Terry Teruo Kawamura, USA

173rd Engineer Company, 173rd Airborne Brigade
Camp Radcliff, Republic of Vietnam, March 20, 1969
Killed in Action

For conspicuous gallantry and intrepidity in action at the risk of his life above and beyond the call of duty. Cpl. Kawamura distinguished himself by heroic action while serving as a member of the 173d Engineer Company. An enemy demolition team infiltrated the unit quarters area and opened fire with automatic weapons. Disregarding the intense fire, Cpl. Kawamura ran for his weapon. At that moment, a violent explosion tore a hole in the roof and stunned the occupants of the room. Cpl. Kawamura jumped to his feet, secured his weapon and, as he ran toward the door to return the enemy fire, he observed that another explosive charge had been thrown through the hole in the roof to the floor. He immediately realized that 2 stunned fellow soldiers were in great peril and shouted a warning. Although in a position to escape, Cpl. Kawamura unhesitatingly wheeled around and threw himself on the charge. In completely disregarding his safety, Cpl. Kawamura prevented serious injury or death to several members of his unit. The extraordinary courage and selflessness displayed by Cpl. Kawamura are in the highest traditions of the military service and reflect great credit upon himself, his unit, and the U.S. Army.

Construction Mechanic 3rd Class Marvin G. Shields, USN

Seabee Team 1104, Mobile Construction Battalion 11
Dong Xoai, Republic of Vietnam, June 10, 1965
Killed in Action

For conspicuous gallantry and intrepidity at the risk of his life above and beyond the call of duty. Although wounded when the compound of Detachment A342, 5th Special Forces Group (Airborne), 1st Special Forces, came under intense fire from an estimated reinforced Viet Cong regiment employing machineguns, heavy weapons and small arms, Shields continued to resupply his fellow Americans who needed ammunition and to return the enemy fire for a period of approximately 3 hours, at which time the Viet Cong launched a massive attack at close range with flame-throwers, hand grenades and small-arms fire. Wounded a second time during this attack, Shields nevertheless assisted in carrying a more critically wounded man to safety, and then resumed firing at the enemy for 4 more hours. When the commander asked for a volunteer to accompany him in an attempt to knock out an enemy machinegun emplacement which was endangering the lives of all personnel in the compound because of the accuracy of its fire, Shields unhesitatingly volunteered for this extremely hazardous mission. Proceeding toward their objective with a 3.5-inch rocket launcher, they succeeded in destroying the enemy machinegun emplacement, thus undoubtedly saving the lives of many of their fellow servicemen in the compound. Shields was mortally wounded by hostile fire while returning to his defensive position. His heroic initiative and great personal valor in the face of intense enemy fire sustain and enhance the finest traditions of the U.S. Naval Service.

Maj. Bruce P. Crandall, USA*

Company A, 229th Assault Helicopter Battalion, 1st Cavalry Division, Ia Drang Valley, Republic of Vietnam, Nov. 14, 1965

For conspicuous gallantry and intrepidity at the risk of his life above and beyond the call of duty: Major Bruce P. Crandall distinguished himself by extraordinary heroism as a Flight Commander in the Republic of Vietnam, while serving with Company A, 229th Assault Helicopter Battalion, 1st Cavalry Division (Airmobile). On 14 November 1965, his flight of sixteen helicopters was lifting troops for a search and destroy mission from Plei Me, Vietnam, to Landing Zone X-Ray in the Ia Drang Valley. On the fourth troop lift, the airlift began to take enemy fire, and by the time the aircraft had refueled and returned for the next troop lift, the enemy had Landing Zone X-Ray targeted. As Major Crandall and the first eight helicopters landed to discharge troops on his fifth troop lift, his unarmed helicopter came under such intense enemy fire that the ground commander ordered the second flight of eight aircraft to abort their mission. As Major Crandall flew back to Plei Me, his base of operations, he determined that the ground commander of the besieged infantry batallion desperately needed more ammunition. Major Crandall then decided to adjust his base of operations to Artillery Firebase Falcon in order to shorten the flight distance to deliver ammunition and evacuate wounded soldiers. While medical evacuation was not his mission, he immediately sought volunteers and with complete disregard for his own personal safety, led the two aircraft to Landing Zone X-Ray. Despite the fact that the landing zone was still under relentless enemy fire, Major Crandall landed and proceeded to supervise the loading of seriously wounded soldiers aboard his aircraft. Major Crandall's voluntary decision to land under the most extreme fire instilled in the other pilots the will and spirit to continue to land their own aircraft, and in the ground forces the realization that they would be resupplied and that friendly wounded would be promptly evacuated. This greatly enhanced morale and the will to fight at a critical time. After his first medical evacuation, Major Crandall continued to fly into and out of the landing zone throughout the day and into the evening. That day he completed a total of 22 flights, most under intense enemy fire, retiring from the battlefield only after all possible service had been rendered to the Infantry battalion. His actions provided critical resupply of ammunition and evacuation of the wounded. Major Crandall's daring acts of bravery and courage in the face of an overwhelming and determined enemy are in keeping with the highest traditions of the military service and reflect great credit upon himself, his unit, and the United States Army.

Capt. Ed W. Freeman, USA*

Company A, 229th Assault Helicopter Battalion, 1st Cavalry Division, Ia Drang Valley, Republic of Vietnam, Nov. 14, 1965

Captain Ed W. Freeman, United States Army, distinguished himself by numerous acts of conspicuous gallantry and extraordinary intrepidity on 14 November 1965 while serving with Company A, 229th Assault Helicopter Battalion, 1st Cavalry Division (Airmobile). As a flight leader and second in command of a 16-helicopter lift unit, he supported a heavily engaged American infantry battalion at Landing Zone X-Ray in the Ia Drang Valley, Republic of Vietnam. The unit was almost out of ammunition after taking some of the heaviest casualties of the war, fighting off a relentless attack from a highly motivated, heavily armed enemy force. When the infantry commander closed the helicopter landing zone due to intense direct enemy fire, Captain Freeman risked his own life by flying his unarmed helicopter through a gauntlet of enemy fire time after time, delivering critically needed ammunition, water and medical supplies to the besieged battalion. His flights had a direct impact on the battle's outcome by providing the engaged units with timely supplies of ammunition critical to their survival, without which they would almost surely have gone down, with much greater loss of life. After medical evacuation helicopters refused to fly into the area due to intense enemy fire, Captain Freeman flew 14 separate rescue missions, providing life-saving evacuation of an estimated 30 seriously wounded soldiers—some of whom would not have survived had he not acted. All flights were made into a small emergency landing zone within 100 to 200 meters of the defensive perimeter where heavily committed units were perilously holding off the attacking elements. Captain Freeman's selfless acts of great valor, extraordinary perseverance and intrepidity were far above and beyond the call of duty or mission and set a superb example of leadership and courage for all of his peers. Captain Freeman's extraordinary heroism and devotion to duty are in keeping with the highest traditions of military service and reflect great credit upon himself, his unit and the United States Army.

**Crandall and Freeman both were Army engineers but served in Vietnam as aviators.*

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ENGINEERS: A LEGACY OF SERVICE

Editor's Note: *The following editorials were written by the respective senior military leaders of the U.S. Army, U.S. Navy, and U.S. Air Force at the height of operations during Vietnam and published in three consecutive issues of* The Military Engineer *at the end of 1967 and the beginning of 1968. These messages—noting the contributions and achievements of engineers during the war—are a reminder that the impact military engineers have is noticed and valued all the way at the top. Whether "lead the way," "can do," or "let us try" the calling of the engineer is one of selfless service. For the purpose of these historical pieces, the text herein is reprinted as published.*

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Prime BEEF Teams in Combat Support

With the introduction of Base Engineer Emergency Forces, known as Prime BEEF teams, into Vietnam the Civil Engineers of the Air Force are contributing vital support to the combat operations. These mobile teams are deployed on temporary duty to perform specific emergency engineering tasks wherever they are needed. My opportunity to observe these teams in action has convinced me that their operation has great significance to the Air Force and the engineering profession.

In an immediate sense, a noteworthy aspect of the Prime BEEF contribution is the progress achieved in the field of emergency repairs and light construction. In a longer view of the national security, our Prime BEEF experience clearly justifies a further investigation of methods which could be applied to engineering problems that might be encountered in combat operations or environments which differ radically from Southeast Asia.

In the current zone of conflict many of the wing commanders in South Vietnam and Thailand assured me that the engineering services supplied by this program were indispensable to the success of their mission. Exemplifying that point are some of the engineering projects completed by the teams. When Bien Hoa began its build-up some months ago, the call went out to more than 70 construction specialists to help provide aircraft revetments and indirect support facilities such as housing units. In completing the steel revetments for the F-100's at that base, the Prime BEEF units greatly reduced the construction time previously required. At Da Nang, I was impressed by the effectiveness of these teams in improving the aircraft parking areas and converting revetments for use by jet aircraft. These revetments were key assets in limiting the damage caused by the enemy rocket attack on the base last July. The emergency construction force at Da Nang had also erected a flare storage building and installed electric power in several new facilities.

These and other projects essential to the air operations against communist forces were completed by the first two teams to be sent to Vietnam. We have since expanded the number of teams to forty-three. Their continuing achievements are emphasizing the benefits of engineering training tailored to the particular demands of a remote and rugged combat zone, and attest the advantages of preselecting the tools and equipment that will enable these highly mobile units to begin their projects as soon as they arrive at forward bases requiring support.

Just how extensively our dependence on forward basing will increase our requirements for emergency engineering support in the months to come cannot yet be precisely measured. We must recognize that the type of limited aggression that we are combating in Southeast Asia cannot be regarded as an experimental and tentative design for conquest. On the contrary, it represents a long-term and highly complex threat which could be directed in the future against other areas of the world. Any such operations in which we would become involved would present an emergency requirement for the engineering support of our combat units at forward bases. This means that the Prime BEEF concept will be an important tactical element for years to come.

In these circumstances, it is apparent that the Air Force, and especially our Civil Engineers, must be prepared to meet long-term requirements. I am confident that, through the continued application of the initiative, experience, and skill that have guided the Prime BEEF contribution up to this point, we will successfully meet these engineering challenges.

J. P. McConnell
General, United States Air Force
Chief of Staff

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Salute to Navy Builders

The year 1967 marked the 25th anniversary of the United States Navy Seabees; the 100th of the Navy Civil Engineer Corps, whose officers lead the Seabees in action; and the 125th of the Naval Facilities Engineering Command (formerly the Bureau of Yards and Docks). Thus for more than a century, Navy men have taken pride in the professional ability, courage, and dedication of their Civil Engineer Corps (CEC) and of the Naval Facilities Engineering Command (NAVFAC), which work together to build and maintain the Navy's world-wide Shore Establishment.

CEC officers are now leading Navy Seabee Battalions in providing construction support for Navy, Marine, Army, and Air Force troops in the Vietnam combat areas. Concurrently, NAVFAC, under CEC leadership, as Department of Defense Construction Agent for Southeast Asia, formulates, manages, and directs the work of civilian contractors in the Vietnam-Thailand building program for all Services. This vast construction is being achieved in underdeveloped countries, where builders must operate 10,000 miles from supply sources while beset by monsoon rains, extreme heat, disease, and enemy forces. Increasingly, Seabee units are moving into tactical support of the fighting forces, penetrating deeper into the Vietnam interior and closer to the front lines of combat in construction support of the troops.

This vast construction is being achieved in underdeveloped countries, where builders must operate 10,000 miles from supply sources while beset by monsoon rains, extreme heat, disease, and enemy forces.

Despite the requirements for Vietnam, NAVFAC continues to meet its world-wide responsibility to the fighting fleet through its professional ability in the fields of engineering, architecture, construction, planning and design, contracts, research and development, land resource management, and maintenance. The work is conducted by a Headquarters in Washington plus fourteen Field Divisions and ten Public Works Centers throughout the world.

The Navy Engineers comprise 23,000 Seabees, 2,000 CEC officers, and 20,000 NAVFAC civilians, and together they have given outstanding service throughout the establishment as well as in Southeast Asia.

Thomas H. Moorer
Admiral, United States Navy
Chief of Naval Operations

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Army Engineers in Vietnam

The performance of United States Army Engineers in Vietnam adds another brilliant chapter to their history. Ever since the 35th Engineer Group went ashore at Cam Ranh Bay in mid-1965 the role of the military engineers in Vietnam has continued to grow more complex and demanding.

There was no opportunity for an orderly build-up of engineer activities. Badly needed port facilities such as those at Cam Ranh, Qui Nhon, Vung Tau, and Saigon had to share the available engineer support with combat activities being conducted over extremely formidable terrain.

There were no easy engineering projects. The excellent harbor at Cam Ranh was almost surrounded by marshes, mountains, and shifting sand dunes. Construction of roads, storage areas, and a jet airfield taxed the imagination and ingenuity of the engineers. Because the enemy chose to fight in terrain which best suited his own abilities there were few engagements in which engineers were not needed to hack helicopter landing pads out of the thick jungle or to assist in the finding and destroying of the enemy's underground headquarters.

In the two years that Army Engineer units have been in Vietnam the cargo handling capacity of the ports has been increased at least threefold and the frustrating sight of ships waiting at anchor for many days or weeks before they could unload has virtually disappeared.

The road network in the Republic of Vietnam, particularly in the remote areas, is rudimentary at best and highly vulnerable to interdiction by the enemy. Air transport has grown to be the most reliable means for moving troops into combat and for keeping them supplied. As the search for communist forces has been pressed farther into the mountains and jungles, the engineers have responded by building scores of airfields which can support C-130 aircraft. Combat engineers with forward elements have cleared uncounted numbers of helicopter pads to make air mobility available when it is needed to support combat maneuvers. Many times the engineers have had to put down their tools and use their rifles when the enemy tried to stop their work.

Perhaps one of the most remarkable aspects of engineering operations in Vietnam is that, faced with these monumental tasks in construction and combat support, the engineers have found time to come to the assistance of Vietnamese villages, hamlets, and families. They have constructed entire communities to provide shelter for refugees who have left their homes to escape Communist terrorism.

In this era of scientific advancement the Army engineers have kept pace with technology in improving their machines and their techniques. In Vietnam, both machines and techniques are being applied by men with determination, imagination, and courage.

Harold K. Johnson
General, United States Army
Chief of Staff

Society of
SAME
American Military Engineers

607 Prince Street
Alexandria, VA 22314
703-549-3800
www.same.org