CHAPTER 8
Support from Corps Laboratories

American soldiers—many unfamiliar with a desert environment—arrived in Saudi Arabia with numerous questions. Can we drive on the surface in the area of operations? Will driving produce dust? What is the best way to control dust? How can we maintain our equipment in the extreme desert heat? Where is the best location to find ground water? What obstacles will we encounter?

The Army canvassed its technology base for new or enhanced capabilities to help these soldiers operate effectively in the desert. All 42 Army laboratories and centers reviewed their programs to generate ideas and products. Research, development, and engineer institutions offered new technology and capabilities, while ARCENT and CENTCOM requested solutions to unique problems they faced in the theater.

Four U.S. Army Corps of Engineers research and development facilities made significant contributions. The U.S. Army Engineer Waterways Experiment Station in Vicksburg, Mississippi; the U.S. Army Construction Engineering Research Laboratory in Champaign, Illinois; the U.S. Army Cold Regions Research and Engineering Laboratory in Hanover, New Hampshire; and the U.S. Army Engineer Topographic Laboratories (now the U.S. Army Topographic Engineering Center) in Alexandria, Virginia, provided invaluable help in topographic support and terrain analysis, water detection, construction and construction management, dust control, and mobility.[1]

Topographic Support and Terrain Analysis

Commanders need a clear picture of the battlefield. In General Schwarzkopf's 27 February 1991 briefing, he emphasized that technology had enabled him to "see" the entire battlefield while Saddam Hussein could not. Corps laboratories provided much of the technology that let U.S. forces view the entire battlefield, which covered 2,100 square miles. Within two weeks of the Iraqi invasion of Kuwait, military units and agencies had depleted existing stocks of maps of the Persian Gulf. Existing topographic maps only covered 50 percent of the area of operations, mostly with outdated or inaccurate information, and no digital terrain analysis existed.

The Defense Mapping Agency was responsible for providing all military services with standard mapping, charting, and geodesy products in digital and hard-copy formats. The Army topographic engineers in the theater customized those products to meet the changing requirements of the battlefield commanders. When the first U.S. soldiers deployed, the Defense Mapping Agency began shipping its standard products, recognizing that some would be obsolete and incomplete. Meanwhile, topographic engineer units in the theater updated and customized these products.

The agency produced 13.5 million maps, most on the 1:50,000 scale that CENTCOM planners had requested, rather than the 1:100,000 scale that the VII Corps requested. Getting the maps into the theater and to the forward deployed units proved difficult because the distribution system was jammed. Faced with distribution problems and a lack of maps at 1:100,000 scale, both corps used their organic topographic units to create maps at 1:100,000 scale from the existing 1:50,000 versions.[2]

Another challenge was converting the Defense Mapping Agency's mapping, charting, and geodesy products from a standard format into the specialized formats required by the terrain analysis systems supporting the theater of operations. No Army tactical system in Operation DESERT SHIELD used LANDSAT, a civilian, multispectral imagery satellite, or the Defense Mapping Agency's digital topographic data directly from the agency's standard 9-track tape. Rather, the tactical systems required different types of media.

The Engineer Topographic Laboratories quickly acquired and transformed thousands of digital products (digital terrain elevation data) from 9-track tapes into floppy disks and digital audio tapes. By January, the laboratory had transformed and dubbed more than 16,000 floppy disks of digital terrain elevation data covering the area of operations and distributed them to various Army units and organizations. It also converted 33 LANDSAT scenes from 9-track tapes to floppy disks or 4-millimeter digital audio tapes.[3]

The Engineer Topographic Laboratories also provided topographic units with prototypes of systems that were currently being developed—including three Digital Topographic Support System prototypes (DTSS–P). This system gives field commanders quick terrain graphics and a better tactical knowledge of the battlefield. It replaces the slow, manual methods currently used to store, process, and analyze terrain information. Faced with the chaos of battle, commanders with this system have access to more current and intelligible terrain products.

The DTSS, including the prototype, automates many terrain analysis processes. It uses standard digital topographic data from the Defense Mapping Agency and updates and disseminates that data in map form to the field. The system, however, relies primarily on specific tactical terrain data that was not yet available from the agency. The Defense Mapping Agency had produced an alternative—interim terrain data—for the U.S. Army in Europe and in the Pacific. CENTCOM, however, had not submitted any requirement for this interim data, so the 30th Engineer Battalion (Topographic) had no experience using the DTSS–P.

Soon after the invasion, the Army began pressuring the Defense Mapping Agency to produce interim terrain data for the Kuwaiti theater of operations. Once the topographic battalion realized that the agency would produce this data, it asked for a prototype. The Engineer Topographic Laboratories shipped one to the 30th's headquarters at Fort Bragg and quickly trained key operators on the prototype before they deployed. But there was not enough time for the operators to become proficient.

Once in the theater, the topographic battalion had difficulty operating the prototype. The battalion's commander, Lieutenant Colonel Paul Ray, later reported that his unit found the prototype to be "useless" because it required a data base built by the Defense Mapping Agency and none existed for Saudi Arabia or Iraq. Six months after the beginning of Operation DESERT SHIELD, there was still no tactical terrain analysis data base or its digital equivalent, interim terrain data. By contrast, VII Corps and the 1st Cavalry Division—the only other units with the DTSS–P in the theater—successfully used their prototypes.[4]

The Engineer Topographic Laboratories also provided CENTCOM units with several established systems. For example, the laboratory rushed three Earth Resources Data Analysis Systems to deploying units. The laboratory's staff helped develop procedures to produce images from LANDSAT and national imagery to substitute for standard Defense Mapping Agency maps that were not available. Topographic units did not previously have the capability to produce image-based map substitutes.

The Engineer Topographic Laboratories also expedited the updating of the TerraBase terrain analysis software and released the updated version on 1 October 1990 to 400 Army and Marine Corps TerraBase users. Finally, with funding from Forces Command, the laboratory loaded some of its own prototype terrain analysis software into 10 Forces Command Automated Intelligence Support Systems (FAISS). It sent those systems to every topographic unit in Saudi Arabia and trained the units to use them. Lieutenant Colonel Ray found the systems to be "versatile and powerful."[5]

To further enhance terrain analysis, the Engineer Topographic Laboratories provided a quick response multicolor printer prototype. The prototype was a commercial system that provided color copies of large-format mapping, charting, and geodesy products. It combined current color photocopying techniques with laser technology in a dry copying process. The major advantage was the ability to produce small quantities of full-color maps quickly while giving the field commander a high-resolution terrain product. It was now practical to run off maps or graphics that would have been prohibitive and time consuming using the old technology.

In early December 1990, the Engineer Topographic Laboratories purchased three Canon Bubble-Jet A1 color copiers with quick response capabilities and shipped one of these large-format, full-color copiers to the 30th Engineer Battalion (Topographic) in Saudi Arabia. The copier was operational by mid-January. It worked so effectively that the battalion later recommended obtaining similar copiers for each topographic company.[6]

The Engineer Topographic Laboratories provided extensive support to Army headquarters and to Army and Marine Corps units in the theater with the Global Positioning System (GPS). This satellite navigation, timing, and ranging system developed by the Defense Department accurately measures position. In Saudi Arabia the distances were so great and existing control points so few that new methods of surveying based on the GPS were used for the first time to support the Army and other services.

Artillery and aviation units needed precise reference points to initiate their inertial positioning systems. Previously, maps, charts, and geodetic products required time-consuming validation or verification. The GPS revolutionized the way the military worked. It quickly provided the data required to help units use a complex mixture of available mapping, charting, and geodesy products. The Engineer Topographic Laboratories provided seven GPS receivers and trained topographic units to use these receivers to establish hundreds of accurate survey control points.[7]

The 30th Engineer Battalion (Topographic) asked to borrow GPS receivers from the Engineer Topographic Laboratories. The battalion had 11 receivers but needed more to equip an additional survey team. In early October, the XVIII Airborne Corps commander asked the laboratory to deploy a two- or three-person survey team with the receivers to support the 30th. The laboratory arranged for the 30th to obtain four single-channel GPS receivers and a laptop computer and trained the battalion's surveyors.

Information derived through the GPS helped commanders plan their strategy and showed troops where they were, where they were going, and where their friends were located. It also helped units detect mapping and charting deficiencies.

One test conducted during the Gulf War illustrated the value and effectiveness of the system. Four units consisting of several vehicles were each tasked to rendezvous at a particular site at a designated time. The units started from four different locations. The two units with GPS receivers arrived at the designated spot within 15 minutes of each other. The third group using a conventional topographic map and compass arrived several hours later. A search team had to locate the fourth unit.[8]

In response to the military's need for better information about the battlefield, Engineer Topographic Laboratories also developed Project "Flying Carpet," a digital mapping system, with funding and direction from the Defense Advanced Research Projects Agency. Using the Army's simulation network and terrain visualization technology, Flying Carpet gave commanders and their staffs a three-dimensional view of the area of operation. It let them view the terrain as if they were flying and looking down on enemy positions. No other Army system had this capability. Evaluators at Fort Knox studied the system to determine if it was ready for use in a war zone.[9]

As part of its support mission, the Engineer Topographic Laboratories maintained volumes of historical information on climate and geography, which it provided to all the services. When Iraq invaded Kuwait, the laboratory's Terrain Analysis Center was completing the military geography portion of the "Army country profiles" of the region. It accelerated production of the profiles of Iraq, Saudi Arabia, and Jordan. A profile served as a strategic planning document, which gave trainers and planners of battlefield maneuvers a detailed analysis of a country's terrain, hydrologic features, and infrastructure.

These profiles helped commanders identify elements that affected troop cover, concealment, observation, cross-country movement, and avenues of approach; availability of construction materials; and drop zones, high ground, and landing beaches for troops and equipment. The military geography portion included information about the country's climate, natural terrain, transportation, telecommunications, military considerations, strategic areas, industrial facilities, energy and construction resources, and maps. Within these categories, analysts provided the most current information on soils, groundwater, surface water, vegetation, and other features such as bridges, highways, and airfields.[10]

Dr. Jack Rinker, one of the Engineer Topographic Laboratories' most renowned terrain analysts, wanted to develop a document that would help terrain teams get, on their own, the information they needed from the imagery. So, in conjunction with the U.S. Geological Survey and after visiting as many deserts in the world as possible, he and others from the laboratory produced the *Remote Sensing Field Guide, Desert.*

The guide contained images and descriptions that let anyone working in the desert predict various characteristics of the terrain. Is the surface hard or soft? Can tanks and wheeled vehicles drive on it? Can people travel over it on foot? Where are the possible sites for ambush? Where are the good observation points?

Shortly after Operation DESERT SHIELD began, Marine Corps officials reviewed a draft of the guide. The Marine Corps commandant directed that the *Remote Sensing Field Guide, Desert* be reproduced as a Marine Corps manual and issued to all the company commanders. The Marine Corps initially produced 4,000 copies and gave 500 to the Engineer Topographic Laboratories to distribute to Army terrain teams. The Marines ultimately printed 20,000 copies of the guide. With help from the Marine Corps, the Engineer Topographic Laboratories also published 1,000 copies of *The Environment and its Effects on Materiel, Personnel, and Operations with Special Emphasis on the Middle East.*[11]

In mid-August, Dr. Rinker and hydrologist Robert Knowles traveled to Fort Bragg to brief the 30th Engineer Battalion (Topographic) on the remote sensing field guide. Drafts had been distributed through Army channels, but few copies had reached the terrain analysts. Knowles had shown soldiers from the 30th a copy of the guide during an earlier visit, and they had requested a briefing.

During the two-day briefing, Lieutenant Colonel Ray became convinced that the data base and guide were "essential" to supporting U.S. forces. "It is imperative," he wrote the Engineer Topographic Laboratories commander, "that you continue this program to meet both the immediate and long term needs of the Army." Ray needed all the information that Dr. Rinker could provide because no other sources were available. "Dr. Rinker's guidance," he concluded, "has significantly influenced how we, as topographic engineers, look at arid terrain."[12]

The Waterways Experiment Station, the Engineer Topographic Laboratories, and the U.S. Military Academy jointly prepared an updated version of the Condensed Army Mobility Modeling System (CAMMS) to install on FAISS. In late November 1990, the Waterways Experiment Station trained soldiers from the 30th Engineer Battalion (Topographic) and personnel from the Defense Mapping School on the use of these systems. The topographic unit later deployed with ten CAMMS-equipped FAISS. The 649th Engineer Battalion (Topographic) also received CAMMS.[13]

At the end of January, ARCENT staff logisticians asked the Engineer Topographic Laboratories for three terrain analysts experienced in interpreting images in desert areas to help the 30th Engineer Battalion prepare and refine terrain information from imagery. Michael G. Barwick traveled to Saudi Arabia on 23 February 1991 with Dr. Rinker. They arrived in Riyadh on the evening of 26 February in a driving thunderstorm to discover that their mission to help the 30th produce terrain products was no longer feasible because of the progress of the ground war. After discussions with Lieutenant Colonel Ray and his staff, they decided to conduct a reconnaissance of selected areas within the theater of operations and hold a class on remote sensing applications in desert environments highlighting equipment and methods.

It was important for Rinker and Barwick to verify the predictions that analysts had made about terrain characteristics for CAMMS and collect air and ground photographs for the *Remote Sensing Field Guide, Desert.* The topographic battalion secured a Chinook helicopter to support the effort. Using an operational navigation chart and thematic mapper imagery, Rinker and Barwick laid out a flight path that covered various image patterns. They also selected areas where the helicopter would land so they could take photographs and gather rock and sand samples. The three-day field trip, which began at King Khalid Military City, successfully provided material that the team could use to verify its previous analysis.

Back in Riyadh the team prepared a course on remote sensing applications in desert environments. The two-week course and field trip—which relied on available material from LANDSAT and other sources—drew students from the 30th Engineer Battalion (Topographic), the 513th Military Intelligence Brigade,

Dr. Jack Rinker and Michael G. Barwick traveled by helicopter to take photographs and collect rock and soil samples.

the 416th Engineer Command, VII Corps, and the British 14th Topographic Battalion. Rinker and Barwick integrated into their lectures hands-on experience analyzing terrain features using LANDSAT imagery. Many participants reported they had learned more about remote sensing and terrain analysis during those two weeks than they had during their previous five months of deployment. For some students who had been conducting terrain analysis from inside their offices, the field trip provided their first opportunity to see the desert.

Rinker returned to the United States on 15 March, having taken numerous rock and sand samples and acquired photographs of the border and other areas. He did not have time to collect samples from as many areas as he wanted, so Knowles, who had another month before redeployment, filled 17 boxes with soil and geologic samples from the Rub al Khali desert and the Asir Mountains. Information gleaned from these samples was incorporated in the data base.[14]

Water Detection

Laboratory support extended beyond terrain analysis to other areas such as water detection. In the dry, hot Middle East, where potable water was scarce, information about the location and quality of water was critical.

From 8 to 13 August, Knowles and two colleagues, Jim Staley and Tom Webster, briefed 20th Engineer Brigade officials at Fort Bragg on water resources in Saudi Arabia. The Engineer Topographic Laboratories answered questions from Army and Marine Corps units and other agencies about the availability of water, groundwater depths, and the production capacities of existing desalinization plants. The Waterways Experiment Station also worked to improve the capability of the Army's reverse osmosis water purification to handle the local sea water.

Hydrologists from the Engineer Topographic Laboratories gave soldiers copies of water resource overlays for the theater. Its Terrain Analysis Center briefed the services about water-related issues, including water quality and availability for military drilling. It assisted the Navy Seabees, the Air Force RED HORSE unit drillers, and Army drillers.

The Engineer Topographic Laboratories had been preparing for contingencies of this type by creating an automated water resources data base. It consisted of map overlays that gave graphic representations of water resources and an automated textual data base with additional detailed information on water features. This was the first large-scale, real-life test of the data base.[15]

A water detection response team, created in 1985, helped Department of Defense water drilling teams find suitable sites for wells. No water detection response team members deployed to Saudi Arabia, but when Knowles deployed as a member of the 416th Engineer Command, he performed a water detection mission. He had trained in Jordan, the Honduras, and Bolivia, and when he deployed he carried current water resource overlays from the Engineer Topographic Laboratories. With information from the water resources data base, host nation sources, and much field reconnaissance, the Army identified and developed enough water resources so its operations never suffered.[16]

Construction and Construction Management

Corps laboratories also provided support in the areas of construction and construction management. In October 1990, personnel from the Waterways Experiment Station instructed the 43d Engineer Battalion at Fort Benning on horizontal construction techniques applicable to Operation DESERT SHIELD. They also developed and tested a rapid repair kit. The kit included a reinforced polyester grid that could be expanded to form an 8-inch thick honeycomb and be filled with sand to form a road base. They investigated the use of roller compacted concrete—including materials selection, mixture proportions, thickness, design procedures, construction methods, and long-term durability.

Another Corps laboratory, the Construction Engineering Research Laboratory, had been developing the Theater Construction Management System. After Iraq's invasion of Kuwait, the laboratory accelerated the development of a test version of the system. Many combat engineer units asked for the system. The Construction Engineering Research Laboratory provided 10 units of the system and commanders used it to plan and execute missions at echelons above corps. Because the system was still in the early development stage, no formal support or training mechanisms existed. As a result, the laboratory trained and supported the 416th Engineer Command and its subordinate units. It also responded to urgent requests to enhance the Theater Construction Management System, provided maintenance support, and converted Army Facilities Component System drawings into compatible formats.[17]

The Construction Engineering Research Laboratory also had completed several studies on commercially available, lightweight, relocatable structures during the 1980s and gave MEAPO information about them. It developed a computer data base with information on suppliers of expedient construction systems and provided that information on floppy disks.[18]

Dust Control

The Waterways Experiment Station continued its research on dust palliatives in a desert environment and developed a manual for selecting proper materials and methods to control dust. It also prepared a guide for military construction called "Dust Control and Soil Stabilization in Dry Marginal Soils (Saudi Arabia)," and an engineer technical letter, "Engineering and Design Dust Control and Soil Stabilization in Dry Marginal Soils (Saudi Arabia)." The Waterways Experiment Station helped MEAPO develop specifications for dust control measures and provided the Navy, Air Force, and Forces Command with information on dust control.[19]

Mobility

Besides addressing problems with terrain analysis and dust control, the Army needed to improve its mobility in the desert. Early in the operation, the Army had problems with wheeled vehicle mobility and with tires—insufficient traction, improper tire pressure, and poor tire performance. Problems reported included excessive tire failures, poor cross-country mobility, poor fuel performance, and air-cleaner and filter problems from dust ingestion.

The Waterways Experiment Station used its Army mobility model to determine the effects of tire pressure and vehicle configuration on mobility in the desert. It provided guidance on proper tire inflation pressures and suggested retrofit and replacement tires for vehicles, which improved overall ground mobility. The Waterways Experiment Station conducted mobility tests of selected tactical vehicles at the Yuma Proving Grounds for a variety of sand conditions and reported the results to the U.S. Army Transportation School.

In mid-November, a Waterways Experiment Station representative traveled to Saudi Arabia as part of a Tank–Automotive Command team to analyze tire damage, endurance, trafficability, composition, wear, and soil interaction on various vehicles. The Corps' Cold Regions Research and Engineering Laboratory used its experience from work on the trans-Alaska pipeline to provide information to the Army Engineer School on how best to cross the large pipelines encountered in Kuwait and Iraq.[20]

Other Laboratory Support

The Corps laboratory support also extended to mine detection. Early reports confirmed the likelihood of widespread use of mines by Iraqi troops. The Waterways Experiment Station worked on a remote minefield detection system. The Army tested the overall mine detection program at Fort Hunter Liggett, California, during September and October 1990.

Meanwhile, personnel from the Engineer Topographic Laboratories recognized the possibility that minefields in dry soils could be detected by various sensors. To test this, in September 1990 they began an effort to build and scan a mock minefield using radar. First they had to find a secure site in the United States with very dry soil, comparable to that in the Middle East. After reviewing soil samples, the Engineer Topographic Laboratories selected the Marine facility at Twentynine Palms, California. There they replicated an Iraqi minefield and flew planes with various radars over the site.

Marines place inert mines at Twentynine Palms, California, to test how well remote sensing techniques detect buried and surface mines.

Personnel from the Waterways Experiment Station; the U.S. Marine Corps' Combat Division Center in Quantico, Virginia; the Naval Air Development Center in Warminster, Pennsylvania; and the Environmental Research Institute of Michigan in Ann Arbor were also involved. The tests revealed that the radar could readily detect freshly disturbed soil and easily distinguish patterns of soil resulting from mine emplacement. Concertina wire bordering minefields provided yet another indicator. However, the disturbed earth also made it more difficult to identify the buried mines.[21]

In another instance, a Waterways Experiment Station camouflage, concealment, and deception team helped the 24th Infantry Division (Mechanized), the 3d Armored Division, and the Air Force procure camouflage materials and trained the soldiers to use them.[22]

When Iraqi troops blew up pipelines in Kuwait and crude oil began pouring into the Persian Gulf, the Cold Regions Research and Engineering Laboratory used its satellite imagery and remote sensing capability to provide information on the location and movement of the oil spill.

Observations

Corps laboratories responded to requests from CENTCOM; Forces Command; Army, Marine, and Air Force units; MEAPO; the Army Materiel Command; the U. S. Army Engineer School; the Defense Intelligence Agency; and the U. S. Air Force Logistics Command. They often provided expertise and support to these agencies that engineers in the theater could not. General Hatch encouraged this support, emphasizing the need to transfer the technology to the customer rapidly as units and individuals rotated into the theater.[23]

At the end of Operation DESERT STORM, Lieutenant Colonel Ray sent a letter to General Hatch praising Colonel David F. Maune, commander of the Engineer Topographic Laboratories, and his staff. "From the start they have been the best friends we have had in the engineer community," Ray wrote. "They helped us solve equipment, training, and technology problems, sometimes before we even recognized we had them....As the topographer of the Army," Ray added, "you have a right to be proud of your deployed topographic engineers and those who gave us such great support from CONUS."[24] Primarily as a result of its outstanding support for Operation DESERT SHIELD/DESERT STORM, Army leaders named the Engineer Topographic Laboratories the 1991 Army Research and Development Organization of the Year.

The Corps laboratories enhanced the technological advantage that U.S. forces had on the battlefield. Their contributions to terrain analysis, water detection, dust control, mobility, and other areas contributed significantly to the success of the operations in the Gulf. The technological advances introduced during Operation DESERT SHIELD will no doubt have a great impact on future contingencies.

Powering the Theater

The U.S. Army's prime power program maintains an inventory of power generation, transmission, and distribution equipment to support the military during contingencies. Prime power assets include land-based 750kw to 1,500kw generators, 1,500kw to 4,500kw power plants, and distribution systems. The Chief of Engineers, who is responsible for executing the Army's prime power program, has delegated this program to the U.S. Army Center for Public Works in Alexandria, Virginia. (At the time of the Gulf War it was called the U.S. Army Engineering and Housing Support Center.)

Prime power teams, stationed at Army bases in the continental United States, Hawaii, Korea, and Germany, provide electrical expertise for facilities engineers. Their electrical equipment augments the electrical generators organic to Army units in the field. Their primary mission is to install, operate, and maintain power plants and up to 3.6 kilovolt amperes of medium-voltage distribution equipment. Their secondary mission is to provide expertise and technical advice on a wide range of electrical power systems. Prime power teams performed both missions in Saudi Arabia and Kuwait during the Gulf War and its aftermath and contributed significantly to the success of U.S. military operations.

During the first months of Operation DESERT SHIELD, the rapid development of the theater created extraordinary power requirements. Initially, the Army used contractors to perform some of the needed electrical work, but qualified contractors were scarce and expensive. Contractors were reluctant to work in the forward areas under the threat of hostilities. Moreover, contracting procedures were complex and time consuming. As a result, war planners needed soldiers with the technical expertise and equipment to expand the commercial power grid and operate the power plants.[1]

On 10 August, Forces Command asked the Army staff to direct the 535th Engineer Detachment (Prime Power), headquartered at Fort Monmouth, New Jersey, to provide prime power teams in support of ARCENT headquarters. The next day, Army officials approved Forces Command's request, and the Engineering and Housing Support Center activated a prime power team of 16 soldiers at Fort Bragg, consisting of elements of the 535th Engineer Detachment from Fort Bragg, Fort Monmouth, and Fort Campbell.

The detachment's commander, Major Dale A. Knieriemen, deployed with this team and a three-person headquarters element on 5 September. At Forces Command's direction, the team left without its large power generation equipment. Since the team could not accomplish its major prime power mission without this equipment, the ARCENT SUPCOM used the team members to perform electrical assessments and hookups. For example, they hooked up a 750kw generator to the 85th Medical Evacuation Hospital, freeing up thirteen 100kw generators for use elsewhere.[2]

Since the Army had no doctrine that defined the control and use of prime power teams, Major Knieriemen had to educate other engineers on the mission and capabilities of his unit. He and the theater engineer decided to retain the prime power units as theater assets.

Forces Command directed that the prime power team work under the ARCENT SUPCOM engineer staff to help plan and develop requirements. Initially the team worked for the ARCENT engineer, Lieutenant Colonel Tomasik, in Dhahran. After Tomasik returned to Riyadh, the ARCENT SUPCOM engineer staff continued to task the prime power team. In late November the 416th Engineer Command arrived and assumed control of the 535th Engineer Detachment.[3]

Soon after its arrival, the team convinced Tomasik that he needed the generator package left behind at Fort Bragg. ARCENT SUPCOM asked Forces Command to deploy the 535th's power generation assets by sea. Specifically it requested nine 750kw generators for base operations at echelons above corps in and around Dammam and Dhahran and for the proposed life support areas. (The XVIII Airborne Corps located two of the life support areas 30 kilometers from a commercial power source, so the Saudi government could not provide them power.) ARCENT asked Forces Command to obtain and ship additional generators and deploy another prime power team.

At Forces Command's request, the Army staff directed the Engineering and Housing Support Center to provide sixteen 750kw generators. These were sent by ship from Charleston, South Carolina, to Bayonne, New Jersey, on 27 October. The generators were shipped from Bayonne on 2 November and arrived in Saudi Arabia on 24 November. A second team deployed from Fort Benning on 21 November and arrived in Saudi Arabia two days later.[4]

In December, as power requirements continued to mount, ARCENT asked for two more prime power teams. In January, Major Knieriemen echoed this request. He explained that the two teams in the theater were providing power at two geographically separated areas—Riyadh and Dhahran—and providing technical assistance and advice to all Army units in the theater. Neither team had adequate resources to perform all these missions. The first team had already received 142 projects, Knieriemen warned, and as the backlog grew, the unit would become less effective. If two more teams with organic equipment deployed, he observed, the 535th could operate three more power plants, perform all the foreseeable secondary missions, and maintain all power generation equipment. If not, the 535th could not deploy any more power plants or provide any further technical assistance and advice to units in the theater.[5]

Recognizing the shortfall, the Engineering and Housing Support Center created Task Force Bravo, comprised of prime power detachments at Fort Bliss, Texas; Fort Lewis, Washington; Fort Bragg, North Carolina; Fort Leonard Wood, Missouri; and Germany. The task force, commanded by Major Kenneth E. Cockerham, consisted of two prime power teams and a small command and control headquarters. Although Task Force Bravo did not arrive in the theater until 1 March, after coalition forces had liberated Kuwait, it provided needed power for Patriot air defense batteries, evacuation hospitals, and command and control headquarters. Elements of the 535th, reinforced now by Task Force Bravo, helped conduct damage assessments and restore emergency power in Kuwait.

When the detachment redeployed to the United States on 1 and 2 April, Task Force Bravo took over the theater's prime power operations. In June, as most U.S. Army forces withdrew from the theater, the task force prepared a plan to replace Army-installed prime power plants with commercially leased and contractor operated generator equipment.

Task Force Bravo's projects included a power plant for the west heliport and redeployment wash racks in Dhahran, plus another power plant at King Khalid Military City. Two soldiers continued to operate and maintain one of the generators in Kuwait City. As task force members redeployed to the United States and Germany on 19 August, a prime power team from Fort Leonard Wood assumed the mission. This team remained in the theater until 3 December 1991.[6]

Prime power teams remained in the theater longer than any other engineer unit and performed more than 300 power-related missions. No other unit had the technical expertise to perform these missions. The 535th's electrical technicians performed power surveys, designed and redesigned electrical systems, prepared construction plans for electrical systems, installed and operated auxiliary power, designed and constructed secondary distribution systems, and inspected electrical work performed by contractors. Though based in Dhahran, the teams traveled all over the theater in teams of two or four to support troop units. Teams provided power for ARCENT's main operations and intelligence center, prisoner-of-war camps, hospitals, clinics, airports, food distribution centers, telecommunications facilities, and various Kuwaiti government buildings.

They powered many key facilities: the theater headquarters' operations center that transmitted Schwarzkopf's televised newscasts, the Patriot air defense batteries in Dhahran that knocked Scud missiles out of the sky, the 85th Medical Evacuation Hospital's operating room where doctors treated victims of the Scud attack on a barracks in a suburb of Dhahran, and the conference site in southern Iraq where Schwarzkopf discussed cease-fire conditions with Iraqi generals. They set up generators for the base camps and were among the first to enter Kuwait. Using their organic equipment, they produced more than 10-million kilowatt hours of reliable, commercial-grade electricity.[7]

Despite initial difficulties because of shortages of electrical equipment and adequate materials-handling equipment, the prime power detachments and teams proved their value during the operation. Although the prime power mission to support the Army in the field was not recognized in doctrine and there were no TOE (tables of organization and equipment) units, the engineers crafted ad hoc organizations to accomplish the mission.

On 24 July 1991, the Chief of Engineers granted the prime power directorate of the Engineering and Housing Support Center the authority to reorganize into a provisional engineer battalion, the first step toward creating a TOE prime power engineer battalion. The 249th Engineer Battalion (Prime Power), headquartered at Fort Belvoir, activated in November 1994, becoming the core of the Army's prime power capability.