Chapter 2

Engineer Information

Engineer information is the result of organizing, collating, comparing, processing, analyzing, and filtering raw data requested by or provided by engineer units. It is then related to specific military activities and used by commanders in planning military operations and construction. Engineer information is comprehensive—it covers fields and levels of MAGTF engineering activity. It is also a part of geospatial intelligence. Engineer information includes, but is not limited to—

- Terrain, encompassing the location, identity, and physical description of natural and manmade features.
- Research, design, and employment of materials; techniques corresponding to that material; and techniques of interest and use to engineers.
- Order of battle of engineer units and similar information on civilian organizations capable of performing engineer missions.

INTELLIGENCE PREPARATION OF THE BATTLESPACE

Intelligence preparation of the battlespace (IPB) is a systematic and continuous approach to analyzing the enemy, weather, and terrain in a specific geographic area. IPB uses enemy doctrinal norms and orders of battle to template enemy forces. It also attempts to anticipate their capabilities and predict their intentions. Engineers must understand the G/S-2 doctrinal and situation template to analyze threat capabilities and the order of battle. The situation template becomes the foundation for the G/S-2 and engineer coordination. For example, obstacle intelligence and templating are developed in concert with the G/S-2's templating of a motorized rifle battalion's defense. The engineer G/S-2 will use the situation template to further develop intelligence requirements (IRs), priority intelligence requirements (PIRs), and named areas of interest (NAIs) to support the event template and the collection plan. The engineer will ensure obstacle intelligence collection is integrated into the collection plan.

The IPB consists of the following three elements:

- Modified combined obstacle overlay.
- Enemy mission and capabilities.
- Friendly capabilities.

ENGINEER BATTLESPACE ASSESSMENT

The engineer battlespace assessment (EBA) is developed in conjunction with the IPB, and focuses on engineer-specific intelligence. The engineer develops facts and assumptions and supports the IPB process by analyzing the terrain and weather and assessing their impact on military engineer operations.

The engineer will analyze the terrain using the following five military aspects of terrain:

- Key terrain.
- Observation and fields of fire.
- Cover and concealment.
- Obstacles.
- Avenues of approach (AA).

Terrain analysis reduces the uncertainties regarding the effects of natural and manmade terrain on friendly and enemy operations.

Modified Combined Obstacle Overlay

Analyzing the military aspects of the terrain is accomplished primarily through preparing the modified combined obstacle overlay (MCOO) developed by the G/S-2 with the engineer's assistance. The MCOO graphically identifies AAs, cross-country mobility classifications, mobility corridors, and existing and future obstacle systems. A slope overlay can determine trafficability and intervisibility for intelligence collection, target acquisition, weapons capabilities, and obstacle integration. These products will be used for COA development and analysis.

Enemy Mission and Capabilities

The second component of the EBA is to analyze the threat engineer mission and capabilities. The first step is to understand the enemy's mission and consider its doctrinal use of engineers. The engineer staff uses the G/S-2's doctrinal and situation template to develop the threat engineer order of battle. The engineer staff officer will further assess the enemy's mobility, countermobility, and survivability capabilities and template the enemy's engineer effort. In coordination with the G/S-2, engineers will recommend IR and/or PIRs, attempt to augment the reconnaissance effort, and monitor the collection effort to confirm or deny the situation template.

In the defense, the engineer templates the enemy's—

- Mobility capabilities and locations.
- Use of scatterable mine (SCATMINE) and other mines.
- Engineers in the reconnaissance effort.
- High-value targets (HVT) (e.g., bridging and breaching assets).

In the offense, the engineer templates the enemy's—

- Tactical and protective obstacle effort and reinforcing fires.
- Use of SCATMINE and other mines.
- Survivability and fortification effort.

Friendly Capabilities

Friendly capabilities are based on available manpower, equipment, resources, and training. Specific friendly considerations include relationship between survivability and countermobility (e.g., construct antitank ditch versus construct hull defilade positions versus construct turret defilade positions). The engineer staff uses the information developed in the mission analysis to produce the friendly capabilities analysis. While task-organizing the engineer organizations, the engineer staff considers the possibility of additional support from the maneuver force and the higher-ranking engineer. Engineers must also consider the availability of critical resources. After determining the total assets available, the engineer staff uses planning factors or known unit work rates to determine the friendly capabilities.

The engineer staff officer combines the analysis of the terrain and the enemy and friendly capabilities to form facts and assumptions about—

- Enemy engineer effort and the most probable enemy COA.
- Critical friendly and enemy tactical events.
- Enemy vulnerabilities.
- Potential effect of these factors on the mission.

The facts-and-assumptions process is lengthy, and the engineer staff must focus on the information required by the maneuver commander and the commander's staff to make decisions. The EBA is a continuous process. Each time new information is collected, the engineer must evaluate the impact and/ or effect on the mission and refine the facts and assumptions as necessary.

TARGETING

The purpose of targeting is to attack vulnerable enemy installations, units, or equipment that best support the mission's accomplishment. The targeting effort is focused on the commander's intent. Targeting is "The process of selecting targets and matching the appropriate response to them, taking account of operational requirements and capabilities. The analysis of enemy situations relative to the commander's mission, objectives, and capabilities at the commander's disposal, to identify and nominate specific vulnerabilities that, if exploited, will accomplish the commander's purpose through delaying, disrupting, disabling, or destroying enemy forces or resources critical to the enemy. See also joint targeting coordination board." (JP 1-02)

The engineer's role in the targeting process is analyzing facility targets and providing targeting information on obstacle plans to the fire support coordinator (FSC). Target analysis examines potential targets to determine military importance, priority of attack, and weapon effects required to obtain a desired level of damage. The engineer staff must analyze the loss or damage to terrain, facilities, and infrastructure and their effect on the mobility, survivability, and sustainability of the force. If the facility or infrastructure is only targeted for damage, the engineer staff needs to determine the level of destruction the target can withstand yet be repairable with organic engineer capabilities for friendly use.

The engineer staff must provide the FSC the following information on obstacles for inclusion in the target list:

- Location.
- Altitude.

- Description (type of obstacle and construction).
- Vulnerability.
- Recovery time (estimated time for the enemy to repair obstacle).
- Accessibility (location of the obstacles to other terrain or cultural features that may limit the direction or angle of attack).
- Importance.

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Chapter 3

Engineering Reconnaissance

Engineer reconnaissance collects data that provides engineers within a MAGTF information on terrain, hydrographics, meteorological, and infrastructure (e.g., built-up areas, transportation networks, utilities, existing natural or manmade obstacles) necessary to support the commanders with their planning for ongoing or future operations. Engineer reconnaissance is vital to successful MAGTF operations. The following are the fundamentals of engineer reconnaissance:

- Orient on the location or movement of the objectives relative to engineers.
- Discover gaps and other weaknesses in enemy dispositions.
- Confirm trafficability and other terrain characteristics.
- Report all information accurately.
- Avoid decisive engagement.
- Develop situation and rapidly—
  - Deploy.
  - Reconnoiter.
  - Take a course of action.
  - Report.
  - Egress.

RECONNAISSANCE MISSIONS

The reconnaissance mission relates not only to the engineer mobility mission but also to countermobility, survivability, and general engineer missions. See MCRP 3-17A/FM 5-34, *Engineer Field Data*, and MCRP 3-17B, *Engineer Forms and Reports*, for the appropriate forms to support the following missions.

Route Reconnaissance

Route reconnaissance obtains information about enemy obstacles (including NBC contamination), route conditions, and critical terrain features along a specific route. The techniques are less time-consuming and are performed more rapidly than other types of reconnaissance. Imagery, maps, and intelligence studies identify likely beach, landing zone, or inland exits and movement routes.

Zone Reconnaissance

Zone reconnaissance is used when the enemy's location is in doubt or if it is desired to locate suitable routes or determine conditions of cross-country trafficability. It obtains detailed information about routes, obstacles, key terrain, and enemy activity in a zone established by definite lateral boundaries.

Area Reconnaissance

Area reconnaissance obtains detailed information about all routes, obstacles, and enemy forces within any clearly defined area. Details can include size and layout of towns; types, densities, and locations of woods; or possible fording sites of water obstacles. It is the most time-consuming of the three types of reconnaissance. Types of area reconnaissance include—

Water Reconnaissance. Initially, the landing force brings potable water ashore. Engineer reconnaissance locates and develops additional water sources ashore. Ground engineer reconnaissance confirms sources previously determined by aerial photos, maps, and intelligence studies.

Engineer Material Reconnaissance. Engineer reconnaissance locates sources of lumber, timbers, standing timber, gravel, rock, sand, and other local construction materials. It may also locate enemy engineer construction equipment and/or facilities such as parts stores, asphalt or concrete batch plants, and heavy machinery.

Airfield Site Reconnaissance. Airfield site selection begins prior to friendly forces going ashore. This can be accomplished by studying maps, photos, and products from other imagery and intelligence sources and flying over the site. Because micro-terrain can severely affect airfield operations, final selection is not done until physical reconnaissance confirms the utility of the landing sites designated prior to the assault and quantifies upgrade and/or repair requirements.

Reconnaissance Considerations

An important consideration in all reconnaissance activities is the impact of large quantities of unexploded ordnance. The EOD support in the

MAGTF should be involved in evaluating the impact of this on any mission. Reconnaissance considerations for missions also include—

- Mobility—
  - Route reconnaissance. Enemy obstacle barrier reconnaissance.
  - Bypasses identification.
- Countermobility—
  - Barrier Planning.
  - Target and/or obstacle folders and target analysis.
- Survivability—
  - Friendly forces emplacement.
- General Engineering—
  - Utility assets location.
  - Water points location.
  - Local construction materials identification.
  - Existing facilities location.

OFFENSIVE AND DEFENSIVE OPERATIONS

Engineer reconnaissance in the offense should be placed far enough forward of the maneuver elements perform proper route and obstacle reconnaissance. This must be done in order to return information to the rear in a timely manner. Engineer reconnaissance should have the capability to—

- Provide a detailed report of all existing and reinforcing obstacles along the maneuver element's axis of attack. The reports should include estimates for breaching.
- Provide information on routes along the axis of advance that may influence the commander's plan such as vulnerabilities and critical choke points.
- Provide information on water, electric, fuel, and other engineer resources.
- Locate bypasses far enough in advance of the lead element to prevent slowing the momentum of the maneuver element's attack.
- Provide information about the countermobility capability of the enemy.

The major use of the engineer reconnaissance in the defense is to provide information for the obstacle and/or barrier plan. This information may be obtained forward of the forward edge of the battle area (FEBA), to the rear of the FEBA, or to the flanks. Specific requirements in the defense are—

- Detailed information on choke points.
- Detailed demolition estimates for the creation of obstacles.
- Resources for obstacle construction.
- Routes in support of a retrograde or lateral movement.
- Route reconnaissance on likely avenues of approach for the enemy.
- Enemy's breaching capability.
- Obstacle emplacement in the enemy's rear capability.
- Close lanes in obstacles during delay and/or defend operations.

identify the location and target number of the minefield.

Report of Completion. The report of completion is usually an oral report to the authorizing commander that the minefield is complete and functional.

Report of Change. The report of change is made immediately upon any change or alteration made in a previously reported minefield and is sent to the next higher commander. It is then sent through channels to the headquarters that keeps the written minefield record.

Additional Reports

Progress Report. During the emplacing process, the commander may require periodic reports on the amount of work completed.

Report of Transfer. The responsibility for a minefield is transferred from one commander to another in a report of transfer. This report is signed by both the relieved and relieving commanders and includes a certificate stating that the relieving commander was shown or otherwise informed of all mines within the commander's zone of action or sector of defense. The report states that the relieving commander assumes full responsibility for those mines. The report of transfer is sent to the next higher commander who has authority over both relieved and relieving commanders.

FASCAM Minefield Report and Record. Since the locations of individual scatterable mines are unknown, the reporting of the minefield is based on the aiming point or points. For example, a remote anti-armor mine system (RAAMS) or Gator minefield would be recorded based on the target location (the grid coordinates given to the firing battery). The size of the minefield would depend on the number of rounds fired (ordnance delivered), the number of aim points, and the angle of fire. Artillery- and air-delivered minefields are recorded by plotting them on a map based on the aim point(s) and a safety zone area specified in the scatterable minefield report and record prepared by the delivering unit. To facilitate the reporting and recording of scatterable minefields, a simple uniform procedure is used. This procedure combines the report and the record into one document—the Scatterable Minefield Report and Record—applicable for all FASCAM delivery systems.

FASCAM Warning. Along with the scatterable minefield report and record, a separate report of the scatterable minefield warning (SCATMINEWARN) is used to notify affected units that scatterable mines will be employed. The SCATMINEWARN report is designed to give units that may be affected by the employment of scatterable mines the necessary warning to plan and execute their operations. The information in the report is kept to a minimum to ensure rapid dissemination. The report is sent by voice, digital, or hard copy means, either prior to or immediately after the mines have been emplaced.

MOBILITY

Mobility is a quality or capability of military forces that permits them to move in time and space while retaining their ability to fulfill their primary mission. A commander must be able to mass forces quickly at a chosen place and time to accomplish the assigned mission. The commander must be able to achieve superior tempo through a relatively quicker observation, orientation, decision, action (OODA) loop than the enemy. Mobility is critical to achieving this situation and maintaining it for extended periods of time over great distances.

Functional Areas

Mobility operations are intended to maintain this freedom of both tactical maneuver and operational movement through five functional areas which are—

- Countermine activities—the detection, neutralization (by breach or bypass), marking, and proofing of mined areas.
- Counter Obstacles—the employment of tactics and equipment to breach or bypass and ultimately reduce obstacles other than mines.
- Gap-crossing—fills gaps in terrain in order to allow passage of personnel and equipment.
- Combat Roads and Trails—expedient preparation or repair of routes of travel for both personnel and equipment.
- Forward aviation combat engineering (FACE) is the preparation or repair of expedient landing zones, FARPS, landing strips, or other aviation support sites in the forward combat area.

Countermine Operations

Countermine operations are all efforts taken to counter an enemy mine effort. Countermine operations are difficult because detection systems are imperfect and mine neutralization systems are only partially effective. Normally, countermine operations using explosive systems will be conducted under enemy observation and fire. Countermine operations include—

- Mine detection.
- Reconnaissance for enemy minefields.
- Breaching.
- Prevention of enemy mine operations.

Detection of Mines

Visual. Visual detection of mines is a reliable and increasingly effective method of locating minefields. The increasing proliferation of FASCAM type mines produces a high percentage of surface laid evidence. FASCAM mines can be recognized from a combat vehicle from a distance of up to 20 meters given normal ground vegetation. Visual detection and recognition of mines should be emphasized during MAGTF employment. The following indicators suggest the presence of FASCAM mines:

- Dust clouds in the terrain without the presence of vehicles or equipment movement or recognizable shell explosions (clouds of dust are created by impact of scatterable mines).
- Small parachutes in the air or spotted blowing on the ground.
- Breaks in an area with otherwise uniform vegetation.
- Mines or dispensing debris (casings, parachutes, etc.) hanging in trees and in underbrush.
- Approaching or departing aircraft (fixed- or rotary wing) in association with any of the indicators.

Auditory. Listening for evidence of FASCAM type mine systems during their employment is a viable method. When artillery or multiple-launched rocket systems project their ordnance overhead and the impact report cannot be heard, the use of FASCAM mines may be suspected.

Probing. Probing is the method of detecting mines by penetrating the ground with an instrument such as a non-metallic or wooden mine probe. Metal objects such as a bayonet or stiff wire are not recommended. When the mines are armed with pressure-only type fuzing, probing is the safest way to locate mines. Modern fuzing systems that employ magnetic, acoustic and/or seismic sensors cannot be safely located by the probing method.

Electronic Detection

Hand-held Systems. The Marine Corps currently employs the PSS-12 mine detector to locate electronically mines below the surface (soil or water). It is a hand-held, battery-powered system.

Vehicular-mounted Systems and Aircraft-mounted Systems. They are currently under development. Systems that identify potential mines from a distance and in some cases, prematurely detonate them before they can endanger a vehicle. Although not yet fielded, these countermine systems have great potential for defeating the mine threat.

Reconnaissance for Enemy Minefields

After detection, the characteristics and limitation of enemy barriers, obstacles, and minefields must be determined using both ground and aerial reconnaissance and remote imagery. Reconnaissance must—

- Locate enemy barrier, mine, and obstacle locations.
- Identify and locate enemy fire support.
- Identify remaining enemy employment capabilities.
- Locate enemy breaching assets.

If possible, it is important to determine the types of mines used and their physical characteristics, i.e., dimensions and material from which manufactured. This can aid the planning of how to clear the minefield.

Breaching Operations

Enemy obstacles that disrupt, fix, turn, or block the force can affect the timing and force of the operation. Most obstacles can and will be observed by the enemy and protected with fires; they should be bypassed if possible. For those that must be breached, constant coordination and integration of all elements of the MAGTF is vital for success. Combat engineers are the key to the orchestration of the operation and are responsible for employing the tactics and techniques necessary to penetrate obstacles in the path of the force.

Breaching operations are some of the most complex of modern warfare, but are not an end unto themselves. They exist as only a part of the maneuver forces operation that is focused on the objective.

The goal of breaching operations is the continued uninterrupted momentum of ground forces to the objective. They should be planned and executed in support of the ground forces' needs to ensure actions at the objective are supported by actions at the breach. Breaching operations require the constant application of the fundamentals of ground combat and the concentrated uses of supporting arms. Fundamentals of breaching operations have evolved in concert with the fundamentals of ground combat and provide a logical and time-proven set of rules. These fundamentals are—

- Suppress the enemy to maneuver and fire.
- Obscure the enemy's ability to observe the operation.
- Provide security for the breach force.
- Reduce the obstacle.
- Reconstitute.

Prevention of Enemy Mine Operations

The most effective means of countering a mine threat is to prevent the laying of mines. Proactive countermine operations destroy enemy mine manufacturing and storage facilities or mine-laying capabilities before the mines are laid. Planners must consider enemy storage and mine production facilities and assets for inclusion on the target lists.

Counter-Obstacle Operations

Many issues encountered in countermine operations apply to non-mine obstacles. Engineer reconnaissance should detect the presence of enemy obstacles and determine their type(s) and provide the necessary information to plan appropriate breaching or by-pass plans developed to negate their impact on the scheme of maneuver.

Another important consideration to be gained from reconnaissance is to anticipate when and where the enemy may employ obstacles that could impede the MAGTF's operations. It is prudent to incorporate plans to deny the enemy the opportunity to establish effective obstacles whenever possible. Achieving this goal can be accomplished by—

- Occupying the area before the enemy can exploit it.
- Preplanning artillery and close-air support to deny or harass enemy units attempting to establish obstacles.
- Looking for or creating alternative routes for the MAGTF's units.
- Using engineering knowledge of obstacles to create contingency plans for breaching or bypassing to allow quick neutralization of the obstacles, if established by the enemy.

Gap-Crossing Operations

Combat engineers can aid gap crossing through employment of their heavy equipment to modify the existing gap or through the use of expedient bridging (e.g., rope bridges, small nonstandardard bridging using local materials). However, CEBs do not possess organic standard bridging equipment. If the plan calls for this type of gap-crossing asset or the situation arises unexpectedly they will need support from the engineer support battalion. See additional information in chapter 5.

Combat Roads and Trails

The ability to move personnel and equipment is essential to maneuver warfare. This ability provides the commander with the means to increase tempo, increase speed, and concentrate mass at crucial times and places. The construction and maintenance of trails and roads are normally considered general engineering tasks and are therefore performed by engineering support units. However, areas at or near the FLOT or time constrictions may require the forward combat engineer units to perform these functions in an expedient manner or for short durations of time until support engineers are available.

The two most likely scenarios that would involve this requirement would be by-pass operations or to support FACE operations. It is important for the engineer commander and staff to only perform this function in support of the maneuver plan. They should not allow engineering assets to be dissipated and thus unable to perform their primary role of supporting the MAGTF commanders operational scheme of maneuver.

Engineers should always strive to take full advantage of existing infrastructure and natural terrain features when constructing combat trails and roads.

Forward Aviation Combat Engineering

Engineers acquired a mission in the battlespace to support aviation assets with the advent of airpower and its associated support requirements. This frontline support will normally take the form of creating expeditionary landing zones for helicopters and vertical and/or short taking off and landing aircraft or parachute drop zones for personnel, equipment, or supplies. Engineers should always strive to take full advantage of existing infrastructure and natural terrain features when constructing expeditionary landing and/or drop zones. Airpower is important to the MAGTF's maneuver warfare and the use of expeditionary landing and/or drop zones can increase the speed and tempo of operations by decreasing turn-around time for aircraft (e.g., FARP sites), decrease travel from rear areas to the forward combat area of personnel, equipment, and supplies, or decrease response times of close-air support mission.

COUNTERMOBILITY

Countermobility is the physical shaping of the battlespace to alter the scheme of maneuver of the enemy. Countermobility operations block, fix, turn, or disrupt the enemy giving the MAGTF commander opportunities to exploit enemy vulnerabilities or react effectively to enemy actions.

When planning countermobility obstacles, it is important to understand the commander's intent, timetable, and scheme of maneuver. Along with available manpower, equipment, and materials, these ultimately determine what is feasible to support the OPLAN. Two key actions in obstacle plans are—

- Avoid obstacle plans that require so much materials and manpower they can not be emplaced in a timely manner to provide useful support to the MAGTF's maneuver plan, i.e., the maneuver elements bypass the obstacle field before it is completed, and the engineer units lose pace with the combat elements.
- Do not impede friendly forces later in the operation with friendly obstacles.

The engineering staff must consider these in the operational plan and ensure the commander is aware of these issues. What is used to impede the enemy may also impede friendly forces in another phase of the operation.

Rarely does the engineer unit have sufficient time, materials, personnel, or equipment to emplace the 'perfect' obstacle plan. Engineers must be creative in their operations. The adage ". . . a good plan implemented in a timely manner is better than a perfect plan implemented too late" is especially true for engineers.

Another consideration is that nonengineer units may need to augment the engineer unit with security and personnel in order to execute countermobility operations. The MAGTF commander and various unit commanders must be aware of this support requirement in planning operations.

SURVIVABILITY

Survivability is the ability of personnel, equipment, and facilities to continue to operate within the wide range of conditions faced in a hostile environment. It includes all aspects of protecting personnel, weapons, and supplies. In order for the MAGTF to survive, it must be able to reduce exposure to threat acquisition, targeting, and engagement. Engineer support tasks such as construction of field fortifications (hardening of command, communication and combat train locations, weapon system firing positions, and infantry fighting positions) are critical to this effort.

Field Fortifications

(DOD, NATO) "An emplacement or shelter of a temporary nature which can be constructed with reasonable facility, by units requiring no more than minor engineer supervisory and equipment participation." (JP 1-02) Engineers construct fighting positions for combat vehicles, direct fire weapons systems, artillery, and air defense. Field fortifications provide a degree of protection from the effects of enemy weapons systems and a more stable weapons platform from which to sustain accurate volumes of fire. They sustain confidence in a Marine's ability to fight effectively where they otherwise could not survive.

Strong Point

(DOD, NATO) "A key point in a defensive position, usually strongly fortified and heavily armed with automatic weapons, around which other positions are grouped for its protection." (JP 1-02) Strong points are heavily fortified battle positions that cannot be overrun quickly or bypassed easily by enemy forces. They consist of an integrated series of well-protected fighting positions connected by covered routes and reinforced with extensive protective obstacles. They are designed to withstand artillery fire, air strikes, and both mounted and dismounted assaults. The enemy can reduce them only by expending significant time, personnel, and equipment assets in the application of overwhelming force.

SPECIALIZED DEMOLITION

Combat engineers and EOD Marines are capable of executing demolition work of a constructive and destructive nature. Demolition missions requiring the use of formulas or calculated quantities of explosives with specific placement to produce the desired effect are normally performed by engineers. These tasks include placing hand explosives near heavy weapons, destroying cave systems; facilities; and equipment, and improving mobility in urban terrain and designated or reserve targets. Engineers are assigned those tasks that require greater control in execution, more precision in effect, and are generally larger in scale and more technical in scope.

The MAGTF's EOD team(s) have specialized demolition skills. They are specifically trained to use explosives and do so more often than combat engineers. The EOD team can help economize demolition materials and assist in the explosives training of combat engineers. Engineers should use the EOD team's practical knowledge for ideas and solutions regarding the commander's mission.

Explosives

Standard Military Explosives. Military explosives procured through the supply system meet certain military specifications that make them less sensitive to the effects of a combat environment than their commercial (nonstandard) equivalents. They are safer to handle and are designed for the common tasks encountered in combat.

Commercial (Nonstandard) Explosives. Commercially available explosives and combustibles are available worldwide and may be encountered and employed by the MAGTF. The greatest deficiency in the use of commercial or expedient explosives is their unknown explosive power. Accurately evaluating their explosive power is difficult thus making their effect unpredictable. Whenever possible, standard military explosives should be employed to support MAGTF demolition requirements. Reserved targets should only use standard military explosives.

Explosive Configurations and Techniques

Economy of Effort. Economy of effort is extremely important to the employment of explosives. By modifying the size and/or shape of explosives, a variety of special effects can be produced that have military significance. The diamond charge and the shape charge are examples of militarily effective demolition using the minimum of explosives, accomplished by modifying the configuration of the charge.

Explosive Effect. Evaluating explosive power and effect against a given material allows the engineer to use the correct type and quantity of explosive at the critical points necessary to produce the desired effect. The result is that only the minimum required explosive is used to complete the task. Additional information on calculating explosives in a field environment can be found in MCRP 3-17A/FM 5-34, *Engineer Field Data*.

Demolition Reinforcing Obstacles. These obstacles are created by the detonation of explosives. Demolition obstacles include structures like road and rail bridges, airfields, and the denial of structures such as seaports, offshore oil rigs, and other facilities and material. There are two types of demolition reinforcing obstacles:

Designated Targets. Maneuver force commanders designate targets for demolition to support their scheme of maneuver or fire support plans. Designated targets are identified and destroyed through hasty or deliberate planning. Although not critical to the commander's mission, designated targets can be destroyed more efficiently through selection of the appropriate demolition, accurate calculation of explosives, and positive charge placement to obtain the desired effect. Infantry personnel create or remove individual obstacles, and engineers create or remove obstacle systems. The difference is the degree of complexity in planning and execution required.

Reserved Targets. Reserved targets are critical to the commander's tactical plan and are specifically controlled at a command level (MAGTF CE/GCE) appropriate to the commanders concept of operations. They are normally astride high-speed avenues of approach or control-significant static energy sources (dams, reservoirs, and earthen overhangs over mountain passes). Reserved targets are usually constructed by engineers in safe conditions (charges calculated and placed waiting to be armed). To ensure proper execution, a target folder (obstacle folder) is prepared. Personnel remain at the target site to guard, arm, and execute the target on order.

Supported units guard and execute most reserved targets within their zone of action or sector of defense. Securing the target site and executing the target do not normally require engineer skills. Depleting engineer resources through security and firing responsibilities at every obstacle location is usually counterproductive to the MAGTF engineer effort. An engineer firing party will remain with certain key targets as designated by the authorizing commander. Engineer firing parties should be used for targets that—

- Represent an advance force objective for enemy forces.
- Are exposed to enemy fires before detonation, thus possibly requiring repair or replacement of demolition or firing circuits.
- Use special demolition (atomic demolition munitions, gas enhanced explosives, etc.) and complex firing systems.

Obstacle Folders

The obstacle folder is normally only employed when time permits the consolidation of all pertinent information required to destroy a target. As a minimum, it will contain the following four parts:

- Detailed target location.
- Explosives and supporting equipment location.
- Preparing and firing orders.
- Demolition report.

Appropriate standardization agreements may govern the control of reserved targets and require additional information with the obstacle folders.

ENGINEERS AS INFANTRY

Engineer organizations have, throughout history, been required to fill the role of infantry as a secondary mission. The CEB is a well-armed and well-equipped organization capable of executing light infantry tasks in conjunction with other combat units. The only significant organizational deficiency is the lack of organic fire control personnel and communications equipment. Augmentation in this area would produce a credible and flexible light infantry organization.

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Chapter 5

General Engineering Operations

General engineering involves activities that identify, design, construct, lease, and provide facilities. Characterized by high standards of design, planning, and construction, general engineering is the primary CSS function performed by engineers. General engineering normally serves the MAGTF at the operational level of warfare, contributing to force sustainment by enhancing the environment to improve operational tempo in the area. It includes horizontal and vertical construction, facilities, environmental impact considerations, provision of utilities, bulk liquids (e.g., water and fuel) support, and EOD.

CONSTRUCTION TYPES

The MAGTF may have extensive requirements for expeditionary horizontal and vertical construction in support of sustained operations ashore. Construction is normally of an initial or temporary standard but can develop into complex construction projects, i.e., the construction of multistory structures or develop paved road networks when assisted by the NCF.

Vertical

Vertical is the improvement or construction of facilities for use by the MAGTF. These facilities can be used in base camps, command posts, and maintenance facilities. Pre-engineered structures should be considered in the planning of any vertical construction project. These structures provide significant savings to the MAGTF in embarkation space and ease of construction and should be used at every opportunity. Types of vertical construction are—

- Wood and masonry.
- Existing facilities rehabilitation.
- Structural reinforcement.

Planning considerations for vertical construction include (total requirement for each type of facility)—

- Beddown.
- Maintenance.
- Command centers.
- Hospitals.
- Bunkers.
- Enemy prisoner of war (EPW) compounds.
- Quantity and quality of existing structures and facilities.
- Amount of new construction required.
- Host nation Class IV availability.
- Unit Class IV stocks.
- Number of engineer units available.

Horizontal

Horizontal construction is the construction required to shape the terrain to meet the operational requirements of the MAGTF. Horizontal construction is—

- MSR construction and/or maintenance.
- Expeditionary airfields.
- Site preparation for beddown facilities.
- Ordnance storage facilities.

The planning considerations for horizontal construction include (total requirement for each type of facility)—

- Tactical situation.
- Soil type.
- Soil stabilization.
- Construction material availability.
- Drainage characteristics.
- Class of road required.
- Location.
- Engineer equipment availability.

NEW AIRFIELD CONSTRUCTION

Construction of an airbase is a complex general engineering construction project performed by a combination of MWSS, ESB, and NCF engineers. However, careful planning and a strict focus on essentials can result in a facility that will support air operations soon after construction begins. Subsequent improvements can be made during use. If construction is guided by an ultimate plan, phased completion of each structure can be designed to serve both expedient operation and the final design of the facility.

The construction schedule in any single construction program is generally established by the theater commander. It is best to complete an air base to its ultimate design in a single construction program. Often, however, it is necessary to design a lower construction standard to get the base into operation within available time and construction support. In such cases, every effort must be made to proceed to the optimum design of the airfield. Repeated modification of a facility plan is to be avoided.

Airfield Facilities

A fully completed airfield includes—

- Airfield runways including taxi ways, hardstands, aprons, and other pavements, shoulders, overrun, approach zones, navigation aids (NAVAIDs), airfield marking, and lighting.
- Personnel facilities including kitchens, dining areas, showers, latrines, general housing, and troop quarters.
- Operational support facilities including ammunition storage, fuel and lubricant storage, and distribution areas.
- Aircraft maintenance, operations, and supply facilities including maintenance bays, base shops, photo labs, operations buildings, base communications, fire stations, weather facilities, general storage, and medical facilities.
- Indirect operational support facilities including roads and exterior utilities, such as water supply and electric power.
- Administration including recreation, welfare facilities, headquarters, and personnel services.

Reconnaissance

Airfield reconnaissance differs from road location reconnaissance in that more comprehensive information is needed. An airfield project involves more man-hours, machine-hours, and material than most road projects. Air traffic also imposes stricter requirements on traffic facilities than vehicular traffic. Consequently, the site selected has to be the best available.

When new construction is undertaken, the planner and the reconnaissance team must choose a site with soil characteristics that meet strength and stability requirements, or a site that requires minimum construction effort to attain those standards.

Airfields present more drainage problems than roads. Their wide, paved areas demand that water diverts completely around the field, or that long drainage structures are built. A desirable airfield site lies across a long, gentle slope because it is relatively easy to divert water around the finished installation.

Support Facilities

Maximum use must be made of existing facilities. However, airfields and heliports may need extensive support facility construction. The advanced base functional components system (ABFC) provides estimates of material, man-hours of construction effort, and material estimates for standard types of facilities.

Expansion and Rehabilitation

Whenever possible, existing facilities must be used. The missions of engineers are so extensive, and the demand for their services is so great that new construction should be avoided. Facility use must be coordinated with host nation authorities because existing airfields, particularly in the rear area, are usually needed by host nation air forces and for commercial purposes. Military operations may require that friendly or captured enemy airfields be modified, expanded, or rehabilitated. When the decision to use an existing facility has been made, a reconnaissance is conducted by the anticipated users and engineers. Support facilities are converted to standards dictated by construction policy. Imaginative use of existing facilities is preferable to new construction. Ground reconnaissance of an airfield previously occupied by enemy forces must be performed cautiously, since facilities may be booby trapped or harbor unexploded explosive ordnance (UXO). Priorities for expanding and/or rehabilitating an existing airfield generally parallel those for new airfield or heliport construction. Procedures, personnel, and construction material requirements for expanding or rehabilitating airfields are usually similar to requirements for new construction and airfield damage repair.

RAPID RUNWAY REPAIR

RRR is one task of the base recovery after attack team (BRAAT). Materials, procedures, and techniques for rapid repair of bomb-damaged airfield runways and taxi ways have been under development for several years. The need for such developments has grown because of the substantial increase in the diversity and lethality of both air-launched and surface-launched weapons capable of inflicting damage on airfield runways and taxi ways.

Since substantial runway and taxi way damage following an attack is expected, quick recovery and support for tactical aircraft launch and recovery operations are paramount. To ensure task accomplishment, the RRR process has been broken down into the following nine elements.

- Base recovery operations command and control.
- RRR planning.
- Airfield damage assessment.
- Unexploded ordnance recognition.
- Minimum operating strip (MOS) selection and/ or layout.
- RRR methods.
- Aircraft arresting system.
- Minimum operating strip marking and lighting.
- Airfield lighting.

Rapid Runway Officer in Charge

The RRR officer in charge (OIC) receives the airfield recovery plan from the combat operations center showing the MOS selected requiring immediate repair. The RRR OIC receives problem area information from the roving controller while directing the airfield recovery process.

Rapid Runway Repair Planning

RRR is a type of large-scale horizontal construction operation that requires immediate results. RRRs are usually spontaneous, and they are performed without the benefit of construction drawings or standardized plans. RRR planning should predicate on the worst-case possible and on historical-based data that aid in determining the needs for a particular airbase. RRR planning considerations include—

- Personnel available to work repair crews.
- Equipment availability and requirements.
- Material requirements.
- Number of craters and spalls that would need to be repaired to achieve an MOS.
- Pre-stage RRR kits and aggregate materials along length of airstrips, and/or fields and/or parking aprons.

BRIDGING SUPPORT

The bridging support for gap-crossing operations is critical to the mobility of the MAGTF. The following include types of gap crossings:

- River-crossing operations. River crossing operations are a type of complex obstacle breach. The equipment necessary to conduct the breach, in this case a bridge and associated resources, is placed under the operational control of the CEB until follow-on engineer forces are in place to assume responsibility for the site.
- Dry-gap crossing. These gaps can range from tank ditches to deep canyons. A key factor in the execution of this operation is the limitation of organic standard bridging assets to span large gaps.
- Overbridging operations. These operations place standard bridging assets over existing bridges to decrease the load on the existing structure.
- Nonstandard bridging operations. Nonstandard bridging operations involve the construction of a bridge using normal construction materials (e.g., wood, concrete, stones) vice standard bridging assets. Due to material and time requirements and intense allocation of personnel, equipment, and materials, this is rarely effective for front-line maneuver elements in the battle zone. This would be more appropriately used in the rear areas in lieu of standard bridging or to replace standard bridging for reuse by the maneuver forces. This function would best be supported by ESB or NCF.

FOLLOW-ON BREACHING AND/OR AREA CLEARANCE

At the FEBA, there are normally two priority tasks for support engineers to perform in maintaining speed and momentum: follow-on breaching (clearing additional lanes through obstacle or mine fields) and area clearance (final reduction) of obstacles or mines. It is imperative that combat forces following the assault force and all necessary support units and supplies pass through the breach as quickly as possible. As there will usually be far more elements and supplies in trace of the assault force than the assault force itself, the initial breaching effort may be insufficient to support the heavy track flow.

Follow-on Breaching

The additional flow of personnel, equipment, and materials will normally require widening existing lanes and breaching and proofing additional lanes. The support engineers will need to plan additional lanes or widening operations that do not endanger elements passing through the obstacle field or cut off usage of the existing lanes.

Area Clearance

A significant cleanup, repair, and maintenance effort is usually required to convert the enemy infrastructure to friendly use. The demolition of damaged facilities, clearance of minefields, unexploded ordnance, battle debris from MSRs, and CSS areas constitute a major part of follow-on operations. As the combat engineer elements will advance with the maneuver forces, the area clearance requirement falls to support engineers and other engineering assets.

ELECTRICAL SUPPORT

Mobile electric power (MEP) support, especially to the MAGTF command element and the command elements of subordinate units, becomes increasingly more important when the MAGTF is unable to rely on local electrical utilities for its power needs. Planning considerations include—

- Commander's priorities.
- Support sources.
- Environmental considerations.
- Power requirements.

BULK LIQUID SUPPORT

All operations rely heavily on the supply of fuel and water. Bulk-fuel Marines and utility Marines in the ESB are responsible for planning and executing bulk liquid operations for the MAGTF beyond the elements organic capabilities. The ESB is responsible for the transfer of Class III (bulk fuel) from amphibious and/or commercial sources, and acts as the main source of fuel storage for the MAGTF. The ESB provides fuel to the ACE, GCE, and CSSE. The ESB also provides the MAGTF with potable water production and storage as well as laundry and shower support when the requirement exceeds the organic capabilities of the elements of the MAGTF. Planning considerations include—

- Commander's priorities.
- Supply sources.
- Environmental considerations.
- Space, terrain, and weather conditions.
- Storage and distribution requirements.
- Support requirements.

EXPLOSIVE ORDNANCE DISPOSAL

EOD assets to support operations in the MAGTF AO are normally found with the support engineer and wing engineer units, i.e., MSSG, ESB (in the FSSG), and MWSS (in the MAW). The operations typically supported by EOD units include—

- Clearing ordnance.
- Rendering ordnance safe.
- Identifying, collecting, evaluating, and exploiting foreign ordnance.

These operations play a vital role in the conduct of operations in the battlespace. The following paragraphs are some examples of when this can occur.

Large, existing minefields (enemy or friendly), ammunition supply points, unexploded ordnance, or the existence of chemical or biological weapons systems can impact the commander's use of the battlespace. Disposition of units, equipment, or supplies in an operation may prevent conventional clearing operations, or operational tempo may not allow time for combat engineers to remain in rear areas to clear these hazards. These situations may require the use of EOD teams to disarm or destroy ordnance without endangering friendly unit.

EOD unit's knowledge of foreign ordnance can aid the commander's planning to avoid situations such as having units remain in the vicinity of an enemy's self-destructing mines. Even after breaching such a field, it would be imperative to keep units away from the field until the self-destruct cycle has completed. Inspecting foreign ordnance to ascertain the existence of chemical or biological delivery systems would be necessary to prevent contamination of units when these items are destroyed.

EOD brings a vast array of skills and knowledge to the engineer commander and the commander's staff that should be incorporated into the MAGTF commander’s planning and execution of an operation. EOD operations require early and continuous involvement of EOD personnel in operational planning. Given the complexity and number of U.S. domestic and foreign ordnance, EOD personnel must coordinate with intelligence, logistics, and aviation staffs to ensure they have a complete understanding of possible ordnance types in the battlespace.

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