
CHAPTER 8

Forward Aviation Combat Engineering (FACE)

HISTORY

USE ON BATTLEFIELD

Forward aviation combat engineering (FACE) tasks on the AirLand battlefield are similar to those of combat roads and trails. Both activities are based on expedient horizontal construction techniques and generally involve combat engineer participation. However, FACE tasks provide freedom of movement for supply, tactical, and reconnaissance aircraft. In this manner, FACE vertically supplements the freedom of movement and maneuver furnished ground forces by the other four functional areas of mobility.

DEMAND FOR AIRPLANES

In World War I, airplanes were used for observation, ground support, and combat for control of airspace. In World War II, great fleets of airplanes were built and used by the combatant nations. Piston-propelled airplanes flew reconnaissance, interdiction, ground combat support, aerial combat, and aerial resupply missions. The Korean War brought two significant developments. The jet engine propelled fighter aircraft and bombers further and faster than ever before. Also, the introduction of the helicopter

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changed how reconnaissance, emergency evacuation, and battlefield control were accomplished. The use of helicopters expanded in the Vietnam War. The tactical use of bombers, fighter aircraft, cargo aircraft, and helicopters was combined to extend combat power in multiple directions over long distances. Thus, in less than a century, the extension of combat, in a vertical dimension, has greatly influenced how, when, and where ground forces operate on the battlefield. Within the context of the AirLand battle, the role of aviation continues to expand with a corresponding need for ground facilities. Whether the ground site is used for landing, rearming, discharging cargo, or protecting the aircraft, it generally requires support from ground forces. For example, Army aviation is now critical to combat, combat support, and combat service support tasks. Thus, engineer support for constructing, repairing, or maintaining aviation ground facilities is essential.

FACE MISSIONS

The development, rehabilitation, and maintenance of aviation ground facilities will be required across the depth of the AirLand battlefield. The types and sophistication of these facilities will vary with their use in the deep battle area, covering force area, or main battle area. At one extreme are ground-based aviation operations in forward areas, characterized by widely scattered aircraft there only for a short time. Aircraft on the ground at these sites are vulnerable to enemy air or ground attack. At the other extreme are Army aviation or Air Force operating bases located behind the main battle area. These facilities are characterized by surfaced runways, ground support structures, and extensive aircraft protective positions.

Types of projects. The combat engineer construction and maintenance effort in support of forward aviation operating facilities is a mobility functional area. Immediately available resources are used to accomplish FACE missions. Expedient techniques are used and extensive construction limited in order to avoid enemy detection. The four

types of FACE projects that fall into this mobility function are—

- Construction of helicopter landing zones and forward arming and refueling points (FARP).
- Construction of low altitude parachute extraction system (LAPES) zones.
- Construction of landing strips.
- Maintenance, repair, and rehabilitation of existing forward aviation maintenance sites.

Need for priority. These individual FACE activities do not imply a necessary sequence. The maneuver commander, in conjunction with the supporting aviation staff officer and engineer, specifies the need and priority for one or more of these activities. This decision is part of the mobility planning process (chapter 3). As with other mobility tasks, the resources used to accomplish the work are reconstituted upon completion. Each FACE mission is divided into several subtasks. The accomplishment of each subtask will vary based on local terrain conditions, tactical situation, and equipment available. Figure 8-1 shows the relationship of the tasks within the mobility mission area. Like combat road and trail activities, reconnaissance of potential FACE sites precedes the preparation of forces and equipment necessary to accomplish any of the tasks. The nature and extent of construction or maintenance of forward aviation facilities is confirmed by reconnaissance.

DEFINITIONS

The terminology of FACE tasks differs from that of the other mobility functions. Two sets of definitions are provided in this section. The first of these focuses on the individual FACE tasks, while elements of each facility are discussed in the second. Forward aviation combat engineering missions follow.

- **Construct landing zone.** Landing zones are required during helicopter movement

of troops and logistics, refueling and rearming, medical evacuation, and reconstitution. Engineer support is rudimentary for each type. All trees must be cleared from the rotor zones. Locations are selected which possess suitable soil conditions to carry helicopter loads without strength improvement. Loose objects, including loose snow, are cleared from the rotor wash area.

- **Construct low altitude parachute extraction system (LAPES) zone.** The LAPES was developed as a means of delivering heavy loads by low level extraction rather than air drop (figure 8-2). These zones require relatively flat, stump-free terrain with geometries similar to those specified in TM 5-330 for a C-130 landing strip. Since the fixed-wing transport aircraft, typically a C-130, does not

FIGURE 8-1. FORWARD AVIATION COMBAT ENGINEERING SUBTASKS

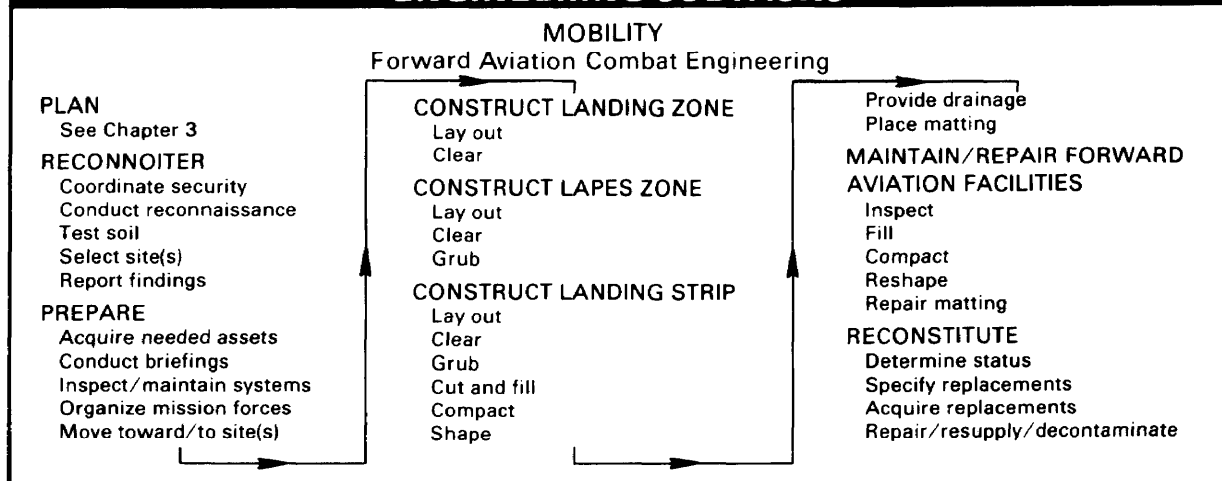
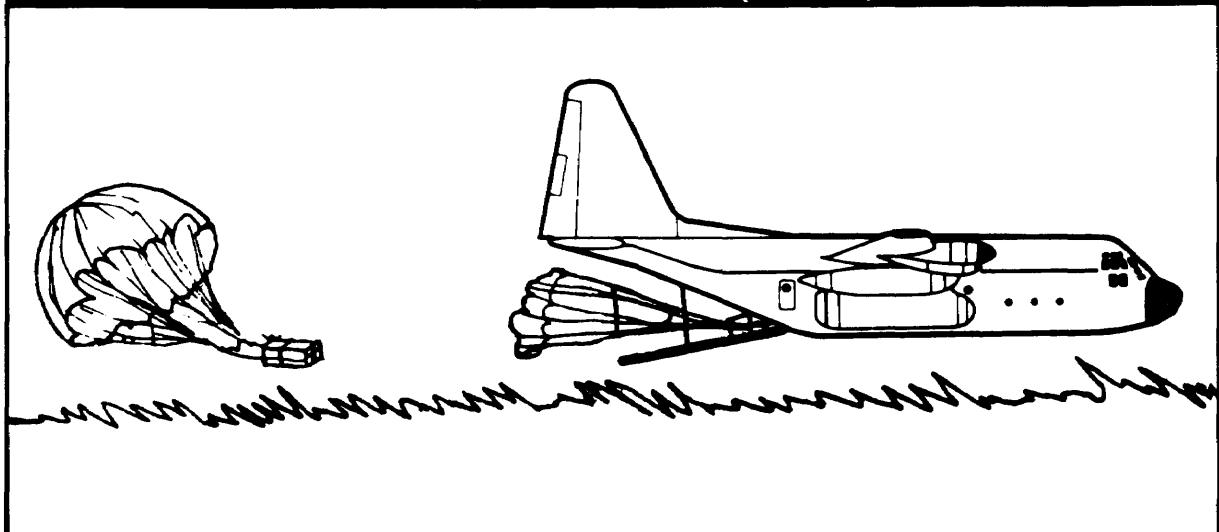


FIGURE 8-2. LOW ALTITUDE PARACHUTE EXTRACTION SYSTEM (LAPES)



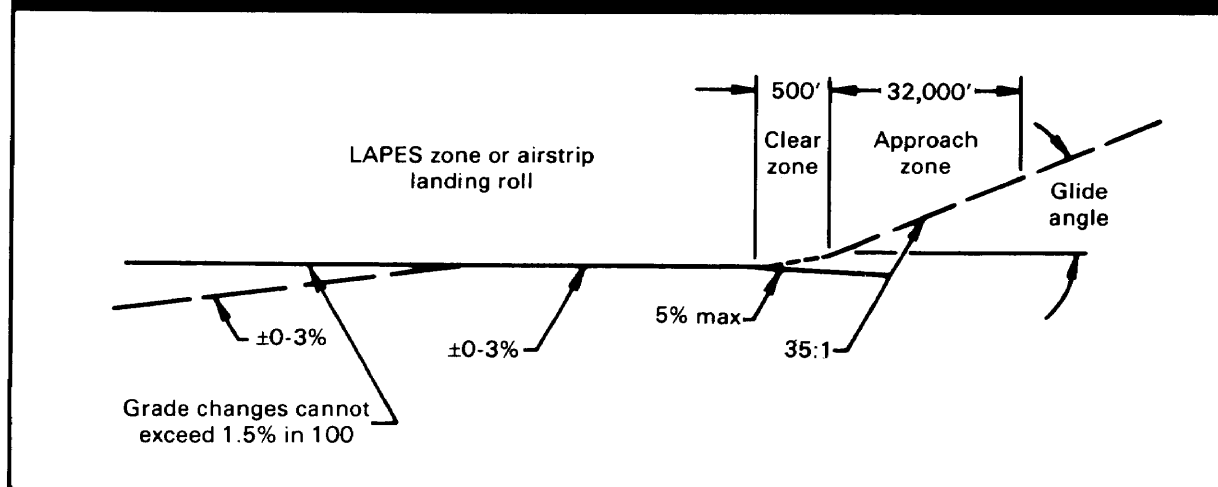
land when discharging its cargo, the ground strength requirements are based on the equipment being discharged. Information on ground strength is provided in TM 5-330.

- **Construct landing strip.** This facility will allow landing and takeoff of specific fixed-wing aircraft. Geometric criteria are established by TM 5-330. Landing strips must be relatively flat with a surface capable of supporting fully-loaded fixed-wing aircraft. Proper site selection is based on the need to minimize the requirement for wearing surface improvement and earthwork.
- **Maintain/repair forward aviation facilities.** Maintenance includes all activities required to correct deficiencies resulting from normal damage and deterioration. Repair deals with restoration of damage due to abnormal use, accidents, and hostile forces. As an economy measure, maximum use of existing facilities should be planned.

Forward aviation combat engineering facility definitions are as follows:

- **Glide angle.** A small vertical angle measured outward and upward from the end of the flight strip, above which no obstruction should extend within the area of the approach zone. It also indicates the safe descent angle for various types of aircraft and is expressed as a ratio, such as 35:1 (figure 8-3).
 - **Approach zone.** An area extending outward from each end of a flight strip, within which no natural or constructed object may project above the glide angle (figure 8-3).
 - **Clear zone.** A cleared area located at each end of the zone or strip. Width is equal to runway, runway shoulders, and runway clear areas. Length is normally equal to the overrun (figure 8-3).
- Flight strip.** Includes area of the runway, shoulders, clear area, overruns, and clear zones.
- Flight way.** Includes flight strip area together with the two approach zones.
- Full touch zone (FTZ).** This helicopter landing area is capable of sustaining the entire weight of the craft. The surfacing of the FTZ is either natural or expedient.
- **Landing strip.** An area of land prepared for the landing and takeoff of aircraft.

FIGURE 8-3. LAPES ZONE AIRSTRIP LONGITUDINAL SECTION



- **Landing roll.** The necessary ground-contact distance, from touchdown to stop, traveled by an aircraft when landing (figure 8-2).
- **Skid touch zone.** This helicopter landing zone is capable of supporting only a portion of the craft's weight. Rotor assist during loading or unloading is required to sufficiently reduce the pressure on the zone's surface.
- **Nontouch zone (NTZ).** A helicopter landing zone without necessary ground stability for touchdown. The aircraft can only hover over this site.

PLANNING CONSIDERATIONS

FACE CAPABILITY

Forward aviation combat engineering, as a function of the mobility system, assists the combined arms team to project combat power over difficult terrain. These tasks allow forces to be transported across or around obstacles, receive logistical assistance, and disperse quickly when required. Forward aviation ground facilities are improved or abandoned depending on the aviation requirements of follow-on forces.

RESPONSIBILITIES

It is the responsibility of Army engineers to plan, design within their areas of responsibilities, and construct forward aviation facilities. To insure that these facilities meet proposed mission requirements, there must be close coordination between the responsible engineer officer and all appropriate ground and air commanders. The engineer is normally dependent on the appropriate commanders for information on the weight and traffic frequency of using aircraft, the facility life, and the time available for construction. Tactical time will often limit planning, reconnaissance, and site investigation activities, as well as the actual construction. In some cases, ground reconnaissance and site investigation will be inhibited by the presence of the enemy, and maximum use will have to be made of air photo interpretation. In such cases, the engineer must make every effort to obtain air photo coverage of the desired area. Normal ground reconnaissance and "on-site" investigations should always be conducted when time and security permit.

Location. Within the established site requirements, the geographic location will be made primarily on the basis of topographic features (grading, drainage, and hydrology), soil conditions, vegetation, and climate. All existing transport facilities, including ports, rail lines, road nets, and other nearby aviation sites, are evaluated.

Security. The mobility planner insures that adequate security forces are provided. An adequate plan must keep troops, equipment, and materials safe from harassment and sabotage during construction.

Construction. The planner evaluates the availability and type of engineer construction forces to determine if construction capability is enough to accomplish the task. The equipment and personnel planning factors given for combat roads and trails in chapter 7 also apply to FACE tasks. However, the planner is limited in certain respects by the initial condition of the proposed site. For example, forward helicopter landing zones are required in certain forward areas because helicopters are the only effective means of transportation. In this case, engineers rappel into the site to clear a zone, thereby limiting the type of equipment that can be used to clear a landing zone. The planner should then compare the type and availability of local construction materials with the overall needs of the project, examining both the naturally occurring in-place materials, which might have to be graded, and the possible sources of select materials for subgrade strengthening.

If it is necessary to import special materials for surfacing, drainage, and dust control, this

must be done in accordance with available time and resources.

RECONNAISSANCE

FACE SITE RECONNAISSANCE

Forward aviation combat engineering reconnaissance differs from road location reconnaissance (FM 5-36) not so much in the type of information sought as in the comprehensiveness of that information. Ordinarily, a FACE requirement (especially airstrip or LAPES zones) involves more engineer resources than does combat road or trail construction. Consequently, for reasons of economy, it is even more important that the site selected is the best one available. Also, certain additional requirements are imposed on a FACE site by the operational peculiarities of flight. As with roads, FACE sites must be both feasible, in an engineering sense, and suitable for the traffic which will use them. Here, too, the difference is one of degree. Air traffic, by its very nature, imposes greater limitations on its traffic facilities than does vehicular traffic.

Advance planning. Advance planning is a prerequisite for execution of FACE requirements, particularly when the AirLand battle initiative has been gained. Tentative FACE sites within enemy territory are selected by map and aerial photograph reconnaissance. This map study is supplemented with any available reports of aerial observers or other intelligence sources. These sites may be either undeveloped potential sites or operating enemy installations. As soon as friendly forces have advanced sufficiently to make these potential sites or installations accessible to reconnaissance teams, they are promptly reconnoitered. In the case of a potential undeveloped site, the object is to verify or amend tentative selections and layouts, and to estimate the material, equipment, and troop requirements involved for the construction. In the case of a captured enemy airfield, a decision to use the existing field or

develop a completely new site must be made. Appropriate estimates of the engineering effort necessary to restore the field are required. Advance planning should include preparation for briefing a reconnaissance party on the specific missions.

Criteria for selection. New aviation ground facilities should be added suitably distant from already operating friendly sites. The mobility planner looks for sites which are large enough, preferably flat with good natural drainage, with unobstructed air approaches, and accessibility to routes of communication. The most likely FACE sites are assigned to reconnaissance parties for appropriate air and ground investigation.

Face site aerial reconnaissance. Reconnaissance, detection, and reporting are important during the planning phase of any mobility task. However, FACE tasks also require aerial reconnaissance with active participation from aviation personnel. Enroute to a particular site or a general area, the engineer observer notes such items as open borrow pits, large stockpiles of construction material, rail and road accesses to the site or area, and changes and additions to maps. The pilot relates flying problems such as approaches and physical obstructions to the type of aircraft that may use the proposed installation. Several circuits are flown around the proposed site at varying altitudes, if the tactical situation permits. In departing from the area, dispersal areas are reviewed, and access roads are checked. Other possible sites are then inspected. Complete notes are kept to minimize reviewing sites already checked. However, a reinvestigation of the final site and any selected alternate sites may sometimes be necessary or desirable.

Face site ground reconnaissance. Map and air reconnaissance should precede ground reconnaissance to discover what specific sites and questions warrant ground investigation. Enroute to the site to be investigated, the reconnaissance party should note and record the general condition of roads and bridges and the location of locally available materials and equipment.

Preliminary check. When the site is reached, the most likely possibilities for construction or repair are swiftly reconnoitered. If the terrain is sufficiently open to permit good general observation, these places may be quickly traversed by vehicle, if possible, or on foot. Lengths are paced, critical slopes are measured, and directions are determined with a magnetic compass. The type of soil is noted, and hasty observations of a few samples are made. A preliminary check of a forward aviation facility can thus be made in 15 minutes or so, provided the country is reasonably clear and open and not mined.

Detailed search. If the country is rough and not sufficiently open to permit quick selection, a more detailed search must be made, usually on foot. The reconnaissance officer follows the perimeter of the site. The officer notes on a large scale map or sketch all obstacles which cannot readily be eliminated, such as gullies, rock outcrops, and swampy places. The reconnaissance of a designated site in the detail indicated here is accomplished as quickly as possible unless hostile forces delay the work.

Role of pathfinders. Engineer units involved in FACE activities frequently work in close coordination with Army pathfinder personnel. Their primary mission is the reconnaissance and establishment of Army aviation landing sites. Engineers should consult pathfinder personnel on matters concerning orientation, size, approach/departure zones, and aircraft capabilities.

PRINCIPLES OF LOCATION

Maximum use should be made of all existing aviation facilities. Existing airstrips and landing zones are often adequate, with a minimum of repair, to accommodate the type of Army aircraft operating in the forward and battle areas. They are, however, seldom adequate to handle high-performance aircraft. Also, helicopters and light planes can often take off and land from existing surfaces such as roads, pastures, and athletic fields. Maximum use should be made of these features. The following paragraphs discuss the principles of location and layout as they apply to mobility FACE tasks. Throughout the entire reconnaissance and preparation phases, problems can be avoided by a wise choice in site location. A project that is started without regard to location principles may not meet the requirements of availability, capacity, or convenience. These principles follow.

Mission. The governing factor in selection of a FACE site is mission fulfillment. Each forward aviation facility is constructed, maintained, or repaired in the most direct and expeditious manner possible to insure continuing aviation support capabilities.

Future expansion. Military operations place a burden on engineer troops to modify and expand previously completed construction. As operations progress, forward aviation facilities built for small aircraft with a limited mission may have to accommodate larger aircraft with far more stringent design criteria. The location of a ground facility should provide for future expansion.

Soil characteristic. In order to meet the design standards of strength and stability listed in TM 5-330, and to minimize the need for removal of undesirable materials, all forward aviation sites should be located on terrain with the best possible soil conditions. Obviously, the location of a FACE site on terrain with soil that can quickly and easily be compacted to the desired standards will facilitate construction and result in a better site.

Drainage. Drainage is often a problem. Because of the nature of most airstrips and LAPES zones, it is often necessary to divert water around the field or construct long culverts and other drainage structures that are difficult to maintain. The bottoms of valleys or other depressed areas should be avoided because they tend to collect water. Airstrips and LAPES zones are constructed across long, gentle slopes because of the relative ease of diverting water around the installation.

Topography. With few exceptions, earthwork is necessary at most points along the FACE project. The amount of work can be minimized, however, through a wise choice of location. The engineer should take advantage of all prevailing grades that fall within the required specifications.

Flightway obstructions. The safe operation of aircraft, either fixed or rotary wing, requires the removal of all obstacles above certain heights, as specified by pertinent design criteria. These criteria vary and depend upon the operating characteristics of the aircraft. For example, most heliports require an approach zone with a 10:1 glide angle, whereas heavy cargo aircraft usually require a glide angle as flat as 50:1. In order to get this glide angle, it is often necessary to remove hills and remove large quantities of earth at considerable distance from the airfield. When siting the airfield, the engineer should keep this glide angle requirement in mind and avoid locations that will need extensive clearing. This is particularly difficult because of the large area involved.

Approach orientation. Normally, landing strips, LAPES zones, and helicopter landing approach zones are oriented in accordance with the prevailing winds in the area. Particular attention should be paid to gusty winds of high velocity in determining the site location. The established direction should

insure 80 percent wind coverage, based on a maximum allowable beam wind (perpendicular to the runway) of 13 miles per hour. A favorable site, however, should not be rejected on this requirement alone. Where dust may be a problem on the landing surface, the runway should be located at an angle of about 10 degrees to the prevailing wind so that dust clouds produced by takeoffs will blow diagonally off the runway.

SOIL TRAFFICABILITY

As mentioned in chapter 7, the procedures for conducting simple soil tests can be found in TM 5-530 and TM 5-545. There are, however, three aspects of soil trafficability that require engineer attention in FACE reconnaissance. These are the possibility of frost action, the shearing resistance of the soil, and the determination of necessary compaction. These three soil characteristics are pertinent to FACE requirements due to the possibility of heavy loads being introduced anywhere on the site surface.

Frost action. Frost action refers to the freezing and thawing of water in soils. The upward displacement of the soil surface from frost action is called frost heave and causes a dramatic loss of bearing capacity. Frost heave may cause damage to forward aviation sites supported on the soil involved. The engineer determines whether or not frost action must be considered in the project design.

Shearing resistance. From an engineering viewpoint, shearing resistance or shear strength is one of the most important soil properties. It refers to a soil's ability to withstand loads under given conditions.

Compaction. Compaction is the process of mechanically densifying a soil. Densification is accomplished by pressing soil particles together, expelling air from the soil mass in the process. Because of certain advantages which accompany the compaction of soils, the process is a standard procedure in the

construction of earth structures. However, certain soils under natural conditions will support considerable loads without need for compaction. They save time and effort in site preparation.

RECONNAISSANCE REPORTING

In order to quickly report the results of forward aviation site reconnaissance, units of all arms and services use a simple and concise format. The airstrip reconnaissance report can be used to report possible airstrip, helicopter landing zone, or LAPES site locations. This format is designed primarily for radio transmission. It can, however, be supplemented by drawings, maps, traces, or overlays for written reports. Much of the detail required can only be provided by qualified engineer personnel. Nonspecialist personnel of other arms include only the detail they are qualified to collect and report. This format implements STANAG 2096. A sample airstrip report is given in figure 8-4.

FIGURE 8-4. AIRSTRIp REPORT

ALFA	Map sheet(s).
BRAVO	Date-time group of information collection.
CHARLIE	Location.
DELTA	Dimensions.
ECHO	Type and condition of the facility. Also type and condition of possible helicopter landing zones and LAPES sites.
FOXTROT	Access by road.
GOLF	Feasibility of expansion (or airstrip extension).
HOTEL	Any other information which could be provided such as work required to make the facility serviceable for sustained limited operations.

EXECUTION

SITE SELECTION

The selection and design of a forward aviation site, such as a landing zone, LAPES zone, or airstrip, depends on several factors. These include the nature of the soil, drainage conditions, construction time, available material, and the engineer equipment and personnel available for technical advice or physical assistance. In certain cases, personnel other than engineers might be required to provide helicopter landing zones or other aviation sites with their organic equipment. In all circumstances, forward aviation facilities are simply designed, practical, and developed swiftly to meet the immediate needs of the mission. In forward aviation combat engineering, consideration is always given to the use of stage construction. This method satisfies the immediate requirements of units and aircraft in the forward areas while allowing follow-on forces to improve the

facilities to meet increased traffic needs. The subtasks involved for each FACE task will depend on the site selected. The construction, maintenance, or repair of forward aviation facilities is primarily influenced by four variables related to the actual site. These are—

- The amount of effort required in clearing a suitable flight path.
- The effort involved in clearing the ground.
- The work and material required to provide an expedient surface of sufficient bearing capacity.

The following paragraphs explain the techniques used to overcome these restrictions. Other techniques can be applied, however, as the procedures in this manual focus on the most expedient means.

CLEARING FLIGHT PATHS

A forward aviation site may be desirable in every way except for such obstructions as houses, railroads, power lines, trees, and other structures. These obstructions could be located in the flight path or near enough to endanger the safe operation of aircraft. The reconnaissance party often selects a site where limited clearing will be necessary before full-scale operations can take place.

CLEARING, STRIPPING, AND GRUBBING

Clearing, grubbing, and stripping operations are essentially the same as those used during road and airfield construction. In FACE construction, the areas to be cleared are usually larger than those in road construction and the number of personnel and amount of equipment used are greater. The disposal of unsuitable materials often requires more planning and longer hauls on forward aviation projects than on road projects. Cleared material can be disposed of and, at the same time, serve a useful purpose as fill material in revetments around hardstands, when such passive measures are desired.

Clearing buildings. There are three principal methods of removing buildings. The building may be completely razed, through explosives or heavy equipment with little or no salvage, or it may be razed in such a way as to conserve as much usable material as possible. The third method is to move the entire building for use at another location.

Clearing roads and railroads. In general, a forward aviation ground facility may be located near roads or railroads if traffic on them will not interfere with the approach or takeoff of aircraft. It is usually unwise to destroy main paved highways and main railroad lines because they will be required later for ground operations, if not already in use. Also, landing zones, LAPES zone, or airstrips near a road can sometimes be disguised as part of the road net. Instead of rerouting a road, which involves great effort, the flight path and landing zone may be built to butt against the edge of the road or even

cross it at grade. However, air traffic will always have precedence over ground traffic.

Clearing power lines. Power lines which are found in the way of construction or in glide angles in forward areas are removed. In rare instances, where the lines may be needed, they can be lowered to within 5 feet of the ground depending on the voltage being carried, **or** a different approach to the airfield could be used. This close-to-the-ground stretch must be protected with a fence and warning signs. As a last resort, they may be installed underground if armored underground cable is available to adequately insulate the lines.

Clearing trees. Criteria for glide angles and approach zones for airstrips and landing zones are described in TM 5-330. Obstructions, such as trees, which extend above the glide angle must be removed. Although glide angle requirements may be met by only topping trees, generally it is best to fell or uproot the trees which extend above the glide angle. To aid in camouflaging, standing trees and brush outside the designated cleared area should not be removed or touched unless necessary. For this reason, care is taken when uprooting trees to control their fall and to avoid breaking off surrounding trees. Timber useful for logs and lumber is stockpiled for future use in bridge, culvert, berm revetments and other types of construction. This timber is pushed or skidded into a salvage area and later removed, trimmed, or milled with little difficulty.

Clearing with equipment. In most cases, engineer equipment provides the most rapid and efficient method of clearing. Such equipment is limited only by unusually large trees and stumps, by terrain which affects its maneuverability, and by maintenance requirements. This equipment includes bulldozers, the M9 ACE, CEV, tractor-mounted clearing units, winches, and powersaws. Pioneer tools are also used in certain types of clearing operations. The selection of equipment is usually limited to that which is available on the job. In all cases, the best type

of equipment for the job should be used. The speed of clearing depends on the material to be cleared, equipment, and methods used. Production rates of equipment under normal operating conditions are used for determining the total time required for the FACE task. With knowledge of the area and type of clearing and the production rates of the available equipment, the time can be estimated and a job schedule prepared. Methods for determining production rates of equipment are contained in TM 5-331 series. A time-estimating technique for the construction of aviation facilities based on site conditions is provided in TM 5-330.

Removing rocks and stripping. In certain FACE operations, all surface rocks must be removed. There are three methods used in this subtask.

Hand methods. Where sufficient time and personnel are available, rocks are picked up and loaded into hauling units by hand. This is a very slow method and is used only as an expedient.

Bulldozer. The bulldozer, M9 ACE or CEV are the most commonly used engineer equipment for moving rocks to a fill or disposal area. The rocks may be pushed by dozers to the designated disposal area.

Power shovels, scoop loaders, and trucks. Clearing an area of surface rocks by this method alone is possible, but it is a slow operation. However, if the rocks are first moved into piles by bulldozers or graders, the trucks can be quickly and efficiently loaded. The rocks can be hauled away from the site for disposal.

Stripping consists of removing and disposing of objectionable topsoil. Some examples of this type of surface material include humus, peat, and muck. Stripping is accomplished at the same time as clearing and grubbing. It can be done with bulldozers, the M9 armored combat earthmover, or scrapers. Stockpile the resulting topsoil and sod for later use.

DRAINAGE

Properly planned, designed, constructed, and maintained drainage facilities are essential to the serviceability of forward aviation ground facilities. Surface water is removed from site wearing courses by adequate crown or transverse slopes. Drainage systems accommodate this water and the surface water from adjacent areas. Natural and artificial means are used, generally in combination, to collect, intercept, control, and dispose of surface water with minimum erosion. Natural elements include streams, lakes, dry runs, and pending areas. Artificial or manufactured facilities used for expedient drainage include gutters, open channels, or ditches. In many instances, artificial drainage facilities can be avoided by grading the airstrip, LAPES zone, or landing zone to facilitate natural drainage. In other cases, required drain capacities may be greatly reduced by shallow ponding basins in nonuse areas. In these areas, runoff from heavy rainfall of short duration may be stored for brief periods of time without interfering with the use of the facility. A detailed discussion of the methods and design for draining both surface and subsurface water is provided in TM 5-330.

EXPEDIENT SURFACING

Landing mats and membranes are used as expedients for FACE site surfacing. Landing mats are used when the strength or smoothness of landing surfaces is not adequate. Membrane surfacing is used where soil strength is adequate but may become too weak when wet. Membrane is placed under all landing mats in high traffic areas such as runways and taxiways, thus providing a waterproof covering for the soil. Membrane is also used for dust control in aircraft traffic areas where chemical dust palliative are either less satisfactory or require greater time or effort to use. Several new materials and techniques are currently under study as expedient surfacings. The types, specifications, and emplacement of matting material are described in TM 5-330. Placement techniques, anchoring, repair, and maintenance of surfacing membrane are discussed in TM 5-337. Helicopter landing zones in heavily

wooded areas can be developed with manual and explosive methods of clearing. Time permitting, or under marshy conditions, the timber felled may be used to prepare a hardened landing pad. Landing pad logs are leveled to insure a satisfactory surface upon which the helicopter skids can rest without danger of skid damage. The perimeter of the landing area must be checked to assure vertical clearance.

MAINTENANCE AND REPAIR

The maintenance of forward aviation sites will be accomplished by combat engineers augmented when necessary by other engineer units. This includes LAPES zones and Army logistical resupply strips in the forward areas including strips used by Air Force C-130 type aircraft. The immediate emergency damage recovery of forward aviation facilities is generally considered to be the minimum work required to permit aircraft to land and take off.

Maintenance during flying operations.

Maintenance and repair work during flying operations must be coordinated with tactical operations and with minimum interference to air and ground traffic. Much of this work must be done at night or during inclement weather. Hazardous equipment must not be left on the landing surface or other areas. Areas under construction or repair must be clearly marked on the surface so as to be visible from the air.

Mud control. Mud on the landing surface is hazardous to aerial traffic because it can impede takeoff and increase the stopping distances for landing or taxiing aircraft. Muddy taxiway and runway surfaces decrease tire life and increase the wear and the necessary maintenance of brakes. Flying particles of mud may cause damage to propellers, rotors, and jet engines. Also, the removal of mud from wheels, struts, and fuselage is an additional maintenance burden. Mud on airfield and heliport surfaces is deposited by vehicular traffic from adjacent

muddy area. It is also caused by the failure of the subgrade due to excess moisture and the action of traffic. Localized soft or muddy spots in an otherwise satisfactory surface are repaired, replacing the unsatisfactory subgrade material with a more suitable one. If the muddy area is too large, all traffic may need to be stopped until the surface dries. In extreme conditions, resurfacing may then be necessary. Under some conditions, surfaces may be kept in operational condition by removing the surface mud. It can be removed by hand shoveling, blading, or the use of a drag.

Repair of captured facilities. An appraisal of the damage to a captured aviation facility precedes the decision to rehabilitate it. Occasionally, the effort to restore a badly damaged site is greater than that required to construct a new one. Damage to the installation includes the war damage by our forces in battle and the deliberate damage by the enemy before yielding the facility. The enemy will usually resort to one or more of the following destructive measures:

- Placing delayed-action bombs, mines, and booby traps.
- Demolishing drainage systems and pavements.
- Placing obstacles and debris in the landing surface.
- Flooding surfaced areas.
- Blowing craters in runways and handstands.

The first priority in restoring a captured airfield is to establish minimum facilities for immediate operation of friendly aircraft. This implies the removal of delayed-action bombs, mines, and bobby traps from the traffic areas, the clearance of debris from the traffic areas, and the repair of craters and the landing surfaces. Adequate repair must be promptly made to the drainage system.

COMMAND AND CONTROL

Combat engineer units have responsibilities for forward aviation facility construction that correspond to their equipment capabilities. Engineer units will assist combat units in forward aviation site development, as required. Combat units are capable of creating helicopter landing zones. Assignment of equipment such as dozer tanks and recovery vehicles provide this basic capability in extreme cases. Extensive combat construction efforts will be accomplished by engineers. FACE requirements will be generated through the division G-3. Aviation assets, organic and attached to the division, along with supporting Air Force elements, will be represented by special staff positions within the G-3. The commander will establish

and control priorities for engineer support requirements. Both division and corps engineers share in this task under the mobility system concept. Division engineers concentrate on repairing existing sites or the expedient development of facilities that enhance the freedom of movement and maneuver for combat aviation units and their supply vehicles. The engineer coordinates other engineer units, when available, to accomplish combat road and trail tasks which exceed the battalion's capability. Corps engineer units, in support of the division, may be employed on an area or task basis. FACE tasks for these engineer units generally involve the construction of landing strips or the expansion of facilities built by divisional engineers.

