

FM 5-6

WAR DEPARTMENT

ENGINEER FIELD MANUAL



**OPERATIONS OF ENGINEER
FIELD UNITS**

April 23, 1943

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ENGINEER FIELD MANUAL

OPERATIONS OF ENGINEER UNITS

CHAPTER 1

MISSION, DUTIES, AND EMPLOYMENT

■ 1. **MISSION.**—The primary mission of engineers in our Army is to increase the combat power of our forces by construction or destruction which facilitates the movement of friendly troops or impedes that of the enemy. Engineers give technical assistance to other arms in construction of protective works, in camouflage, and by supply and maintenance of certain equipment and materials. They engage in combat when necessary.

■ 2. **DUTIES.**—*a. In theater of operations.*—(1) Engineers facilitate the movement of troops by—

(a) Removal or passage of obstacles.

(b) Provision of bridges or other means for crossing streams.

(c) Construction and repair of roads.

(d) Provision of port and landing facilities for movements by water, including those for landing on hostile shores.

(e) Construction of air bases, advance landing fields, and other ground facilities for aerial operations.

(f) Removing obstacles to the landing of gliders, and preparing hasty landing fields in enemy territory to facilitate the operations of airborne troops.

(g) Production, reproduction, and distribution of maps and map substitutes.

(h) Maintenance and operation of inland waterways.

(i) Construction, major repair, and extension of railroads.

(2) Engineers impede enemy movement by executing demolitions and creating obstacles. Often they are called upon to defend these obstacles, particularly those on the flanks or rear. At times, demolitions are executed behind the enemy lines.

(3) Engineers give technical assistance to other arms—

(a) *In forward areas* by furnishing technical advice, tools, and engineer supplies for defensive field works and camou-

flage, by supervising and inspecting camouflage practice, and by the construction of works requiring special equipment and training. They supply water to all troops.

(b) *In rear areas* by constructing, repairing, and maintaining all structures of every character, except telephone and telegraph systems and other signal communication. They operate all light and power systems, water supply systems, and all other utilities of general service, except such as are assigned specifically to other services.

b. *In zone of the interior.*—Engineers are charged with duties in the zone of the interior similar to those in the theater of operations, and also with the following:

(1) Providing fortifications and protective works by—

(a) Joint participation in selection of sites.

(b) Preparation of plans and estimates.

(c) Construction and repair of fortifications, including installation and maintenance of accessories such as searchlights, electric power and lighting systems, and fire control systems.

(d) Developing camouflage technique and protective plans for the passive aerial defense of vital military and industrial installations.

(2) Preparing, reproducing, and distributing military maps, including—

(a) Cooperation with other mapping agencies, governmental or private.

(b) Reconnoitering and surveying for military purposes.

(3) Developing, procuring, storing, and issuing certain classes of supplies and equipment.

(4) Executing river and harbor improvements, flood control measures, and such other civil works as may be assigned by law or by executive order.

(5) (a) The acquisition of sites for all military posts, camps, stations, air bases, and fields and their construction and maintenance; also of factories and depots operated by the Army, except facilities used by a single arm or service when exempted by the War Department.

(b) The operation of all utilities (except signal communication) for these installations, including those shops and plants directly connected with maintenance and repair of utilities.

■ 3. ENGINEERS WITH COMBINED-ARMS UNITS.—a. Engineer troops form part of all large commands in the ground and air forces, and in the services of supply.

b. An engineer officer is provided on the staff of the commander of each division or other large unit. In addition to his staff functions, this officer commands all engineer troops not assigned or attached to subordinate echelons. In a theater of operations he is termed chief engineer, and is called army, corps, division, or air force engineer in the corresponding units. In the various commands he is known as engineer, base command, or engineer, service command, or engineer, communications zone.

c. Engineer troops also may be assigned or attached to troop units, combat teams, or other tactical groupings. Under such conditions the engineer officer commanding these troops will perform the duties and have the responsibilities of a unit engineer.

d. No statement in this manual of duties of unit engineers and engineer troops should be construed as limiting the authority of the unit commander to which they are assigned.

■ 4. EMPLOYMENT OF TROOPS.—a. Engineer units should be employed primarily on work requiring technical skill or special equipment. They should be assigned tasks in accordance with approved priorities based on the importance of the work to the entire unit. They must not be regarded as pools of laborers and mechanics to be allotted individually to various operations.

b. An engineer organization is made up of a number of working units, each capable of executing a definite type and amount of work when commanded by experienced supervisors. Each unit is so organized that it may be combined systematically with other units into larger groups for ease of control and supply. In combat engineers the squad with its tools and transportation is the basic unit, while in other general engineer organizations the basic unit for operations is the platoon. Platoon, company, battalion, and other organizations are agencies provided to coordinate, supervise, and inspect the work of groups of these working units, to care for supply and administration, and to furnish men and equipment for tasks beyond the capacity of normal means

assigned to the unit. The function of engineer supply is centered in the headquarters company; but platoons and lettered companies facilitate the distribution of supplies to subordinate elements and if necessary assist in the engineer supply of larger units.

c. Commanders of engineer battalions or regiments apportion work to major subordinate units and assist the operations of lower units by furnishing transportation, supplies, special equipment, and expert technical personnel. The unit commander and his staff make frequent visits to the sites of work being done, see that it is energetically prosecuted, and take corrective measures when necessary to promote its successful completion.

d. Company commanders usually divide their work into platoon tasks. The company headquarters keeps platoons supplied with materials, and supervises and inspects their work. Platoon commanders assign tasks to squads.

e. When one engineer unit is attached to another, it should work under its own commander.

f. If two or more *similar* engineer units are assigned to the execution of a detached mission or are attached to some other unit, a higher engineer headquarters should be furnished to command both elements. For example, instead of furnishing two platoons for a mission it is preferable to assign or attach a company less one platoon. This is especially important when engineers are attached to other arms.

■ 5. WORK ASSIGNMENT.—Commanders of engineer units subdivide engineer work by making area or task assignments or combinations thereof.

a. An area assignment gives a unit responsibility for all engineer work within a definite area. For example, a combat company may be required to perform all necessary engineer work in the zone of action of an infantry regiment. Area assignments should not be changed unnecessarily.

b. Task assignments give each unit responsibility for performing one or more specific duties. For example, a company may be assigned the particular task of repair and maintenance of an important road.

c. Combinations of the above methods of assignment frequently are employed in assigning engineer missions. A

particular task may be emphasized when an area assignment is given. For example, an engineer company may be given an area assignment by ordering it to do all necessary engineer work in the zone of action of an infantry regiment, with particular attention to assisting the advance of artillery. In other cases, a general service battalion may be ordered to execute all general engineer work in a specified area and to maintain a corps supply road outside that area.

■ 6. ORGANIZATION FOR WORK.—*a.* In executing work, troops should be placed on tasks under their own leaders without breaking up organizations unnecessarily. The size of a work party should be determined with great care. Too few men will not get the work done on time; excess manpower is wasteful of means needed at other places. Even when the work must be expedited to the utmost, limitations of space, tools, or materials will usually place a limit on the number of men who can be employed effectively. In such a case the working party should be divided into shifts and the shift not working allowed to rest. It may be required as a reserve to assist the security detachment.

b. If possible, troops should be kept on assigned tasks until completed. Work plans of larger units should provide for reserves of tools, supplies, and manpower to meet emergencies.

c. Work must be organized so that units may be withdrawn if necessary without disrupting the entire project. A job should be planned with a view to maximum utility at any stage of completion. For example, one railroad siding completed ready for use is better than several partially completed; and a reasonably passable road is better than one with one section completely finished and the rest impassable.

■ 7. EMPLOYMENT OF MOTOR TRANSPORTATION.—All engineer units except airborne engineers have sufficient motor transportation organically assigned to carry their tools, equipment, and some supplies. If this transportation is taken away, the troops cannot function as engineers except where the tools have been dumped. Some units, particularly combat engineers, have sufficient transportation to carry all personnel. If an engineer unit needs additional transporta-

tion it should be furnished in the same manner as additional supplies. Thus additional trucks for a lettered company should be furnished from the battalion or headquarters and service company and not from another lettered company.

■ 8. ENGINEERS AS COMBAT RESERVE.—When it is probable engineers will be needed in combat, they may be ordered to be prepared to assemble on short notice as a general reserve. However, such action should be taken only after weighing carefully its value as compared to the restrictions it imposes upon the performance of necessary engineer work. When sent into battle, engineer units should be under their own commanders.

■ 9. ENGINEER WORK BY TROOPS OF OTHER ARMS.—*a.* When an engineer officer is charged with execution of work requiring labor by troops in addition to those in his command, he should requisition the necessary troops from his immediate commander. This requisition should specify the number of officers and men required, the time and place, and the name of the engineer officer to whom they are to report. The commander of the requisitioned troops should require his officers and noncommissioned officers to execute the work in accordance with the technical instructions of the engineer officer. The engineer officer, either directly or through officers or noncommissioned officers representing him, should point out on the ground what is to be done and should provide the necessary technical assistance. (See AR 100-5.)

b. Normally all organization of the ground, including camouflage, obstacles, and hasty mine fields for close-in defense, is executed by the troops who are to occupy and defend the positions. Engineer troops furnish necessary engineer tools, supplies, technical advice, and assistance. Engineers should be used to create obstacles and mine fields on exposed flanks and in the rear, and other works which benefit the command as a whole or require special skill and equipment. When defensive positions are to be prepared before the arrival of the troops who are to occupy them, siting and construction frequently are delegated to engineers in accordance with general plans approved by higher authority.

CHAPTER 2

ENGINEER PLANS AND ORDERS

■ 10. FUNCTIONS OF COMMANDERS.—*a. Formulation of plans.*—An engineer commander in any situation demanding action must take certain definite steps in logical order. First, he makes an estimate of the situation, culminating in a decision. Next he evolves a plan to put this decision into effect. In many cases he must have this plan approved by higher authority. Finally, by means of orders, he conveys this plan to his subordinates and supervises it to insure proper execution.

b. Reports and bulletins.—He requires from subordinates timely submission of reports prescribed by his own or higher headquarters, keeping these to a minimum, avoiding duplication, and insisting on conciseness and brevity. He issues bulletins giving the engineer situation, engineer information, and instructions as to approved methods of procedure.

c. Staff participation.—The extent to which each of the above steps is performed by the engineer commander personally or by his staff depends upon the situation, the time element, distances involved, size of command, and characteristics and training of members of his staff. In a small unit with no staff, such as a platoon, the commander must perform every step himself. In larger units, the greater part of the work will be done by the staff. The more experience and training the members of the staff attain, and the more conversant they become with the commander's policies, personal wishes, and characteristics, the more the commander can rely on them for planning details. Decentralization in training should be initiated early and carefully developed. However, the responsibility for the decision, plan, orders, and supervision always rests entirely upon the commander.

■ 11. ENGINEER ESTIMATE OF SITUATION.—*a. Whenever the engineer is confronted with a new problem or task, his mind should function according to a well-defined process in arriving at a decision. This process of reasoning is known as the*

estimate of the situation. Whether written or unwritten, an estimate of the situation is a necessary mental process preliminary to every order issued. In this chapter, only estimates for engineer work and missions are considered. Estimates for tactical situations involving the engineer unit in combat are made in accordance with FM 101-5.

b. The time available for engineer commanders to reach decisions varies greatly in different situations and echelons. The engineer commanding a small unit is confronted frequently with emergencies, allowing little time for deliberation. Before he can reach an intelligent decision, he must consider quickly certain essential factors, including his mission, means available to him and to the enemy, conditions in his area of operations, and the best course of action to take. This can be done rapidly and will result in a weighted decision rather than one based on snap judgment. The unit engineer of a large force, such as a corps or larger unit, may require, under some circumstances, days or even weeks of careful thought and study prior to reaching a decision. In such a case he utilizes all of his staff; everything that may possibly affect the problem is considered, all probable contingencies are foreseen, and a decision is reached only after the most exhaustive analysis. These examples illustrate the extremes; but the mental process involved in each case is fundamentally the same, varying only in extent of detail.

c. In engineer operations, the engineer often finds that the obstacles to be overcome are imposed by natural laws and physical conditions rather than by the military situation. The strength, morale, and plans of the hostile forces mainly concern the tactical commander, while the engineer is concerned to a greater extent with congested communications, disintegrating roads, destroyed bridges, and the ever-present problem of how to accomplish his mission with insufficient time, men, transportation, and materials.

■ 12. DETAILS OF ENGINEER ESTIMATE OF SITUATION FOR SMALL UNITS.—For the engineer of a small unit, an estimate of the situation in the following form is appropriate:

a. *Mission*.—Brief statement of work to be accomplished.

b. *Obstacles to be overcome*.—(1) Time limitations.

(2) Special difficulties due to location, such as unfavorable

terrain, swift current, poor soil for foundation, and probable rise or swollen condition of stream.

(3) Difficulties anticipated in getting men, tools, and construction materials to site.

(4) Probable enemy interference.

c. Means available.—(1) Men.

(2) Materials.

(3) Equipment.

(4) Transportation.

(5) Assistance available from engineers of other echelons or from other troops.

(6) Other factors.

d. Plans.—List various plans for accomplishing mission and state advantages and disadvantages of each. Under this heading, consider various types of construction applicable and problems connected with each type, such as sources of materials, time required, and kind and amount of assistance which should be requested. At the end, a brief general reconsideration of the entire problem is advisable to make sure important factors are not overlooked. From this, the best plan is determined.

e. Decision.—State briefly. Should cover essential elements of plan adopted.

■ 13. ENGINEER ESTIMATE OF SITUATION FOR DIVISION, CORPS, OR ARMY OPERATIONS.—When the estimate is more complicated, as when the engineer must assist other troops in an operation and employ his troops in many different activities, the scope of the estimate necessarily becomes greater and the following form is appropriate:

a. Mission.—Usually stated: "To assist (attack) (withdrawal) (organization of position) of (division) (corps) (army)."

b. Duties.—Statement of work desirable to further mission. Should be listed under headings given in paragraph 2 so far as they are applicable. Under each heading should be stated briefly quantity of work considered necessary, approximate force required for its accomplishment (including security forces), and any special difficulties connected therewith.

c. Means available.—(1) Time.

(2) Men.

- (3) Materials.
- (4) Equipment.
- (5) Transportation.
- (6) Assistance in above items:
 - (a) Available in other engineer echelons.
 - (b) To be requested from unit commander.
- (7) Other factors, including engineers to be furnished to subordinate units.

d. Plans.—List various plans for distribution of force over different tasks, with regard to relative importance or announced priority of tasks and relative merit of various plans. A balance must be struck between importance of various tasks and necessity for obtaining a commensurate return for effort expended. This resolves itself into a consideration of those tasks that must be curtailed or eliminated, and those on which effort must be concentrated.

e. Decision.—State briefly. Should cover essential elements of plan adopted.

■ 14. **ESTIMATE OF TERRAIN.**—A unit engineer must be prepared at all times to furnish an estimate of the terrain to the unit commander. To do this he must require continuing reconnaissance of the ground and must keep himself informed of all tactical plans in effect or contemplated. When a new line of action is being considered, a terrain study is essential. The unit engineer must furnish such a study. It should be a brief and accurate analysis.

■ 15. **OUTLINE FOR TERRAIN ESTIMATE** (see FM 5-15 and 101-5).—The purpose for which a terrain study is made, and considerations such as mission, enemy capabilities, tentative lines of action, and the commander's decision, must be kept in mind at all times, as they limit the area of terrain to be considered and the scope of the estimate. The study may be presented orally or in written form, depending on circumstances. If written, normally it will be accompanied by a map illustrating the important points covered. If it is for the use of the unit commander the study *must* be brief. Inapplicable paragraphs or items, and statements of fact already known to all concerned, unless of great importance, should be omitted. The outline given below is appropriate:

a. Purpose and limiting considerations.—State briefly.

b. General topography of area.—(1) General nature of terrain.

(2) Drainage system.

(3) Ridge system.

(4) Communication (such as railroads, roads, waterways, airfields).

(5) Forests and swamps.

(6) Areas suitable for mechanized operations.

c. Military aspects of terrain.—(1) Consider terrain methodically by natural subareas. Within each subarea, consider from own and enemy standpoint effect on possible military actions of following terrain elements:

(a) Avenues of approach and communication.

(b) Obstacles, natural and artificial.

(c) Concealment and cover.

(d) Observation.

(e) Fields of fire for all weapons.

(2) The analysis should include possible landing fields and suitability of terrain for mechanized operation.

d. Critical terrain features.—State important terrain features which are desirable objectives for the enemy or own troops. These objectives will be determined after considering the capabilities of foot, motorized, mechanized, and airborne troops and will include such features as dominating hills, vital communication centers, critical defiles, and important towns. Areas which should be avoided as difficult or impassable to either foot or vehicular traffic should also be pointed out.

e. Tactical effect of terrain.—Summarize effect of terrain on enemy capabilities and own possible lines of action. It should be stated for each capability and line of action in turn.

f. Maps.—Submit map or maps necessary to illustrate simply and graphically information outlined above.

■ 16. PLANS.—*a.* In order to carry his decision into effect, the engineer commander must formulate a plan. The amount of detail in it will depend upon the nature of the problem and the time available. It should include details of the assignment of available troops and the allotment of available materials, transportation, and equipment. A properly prepared plan is comprehensive, flexible, and simple.

Such a plan, when approved by higher authority, is the basis for orders issued to the engineer troops, and also for the engineer paragraphs of the field and administrative orders of the tactical unit to which the engineer unit belongs. The complete plan in written form sometimes is published as the engineer annex to such orders.

b. The details of the plan are generally worked out by the staff of the unit engineer based on his directive, and prescribe the employment of each subordinate unit. Since the commander is responsible for all instructions issued to his command, the entire plan must have his approval or his authorization. In an emergency, this authorization may be given in advance, the staff being directed to formulate the plan and issue, in his name, the orders necessary to put it into effect.

c. The unit engineer and his staff must prepare alternate plans for possible changes in the situation. When a contingency develops, one of these plans usually can be quickly adapted to it and translated into orders.

■ 17. BASIS FOR PLANNING.—To effect the maximum coordination with other arms and to render them the greatest service possible, engineers should base their plans upon the following considerations:

a. *Priorities.*—The first necessity in engineer planning is a clear determination of priorities for the engineer work. Such priorities are based on the needs of the tactical unit as a whole in fulfilling its mission in the most efficient and coordinated manner. Normally these priorities are recommended to the proper general staff officer by the unit engineer and are based on his study of the tactical plan and on consultation with the general and special staffs. Upon receipt of the unit engineer's recommendations, higher authority decides the relative importance of various tasks. It is only in this way that the engineer effort can be applied with the greatest effect.

b. *Simplicity.*—All work of engineers in war must be simple in conception, design, and execution. No construction should be better than is necessary to meet bare requirements. It should be accomplished in minimum time with greatest

possible economy of material and force, and plans therefor should be flexible to meet priorities changing with the tactical situation. For most structures, factors of safety can be extremely low and standards of durability limited. Standardization is desirable and will facilitate work in rear areas; however in advanced areas, economy of materials and transportation may often dictate a deviation from standard design and a resort to expedients utilizing locally available resources. Officers and men alike must be trained to locate materials by engineer reconnaissance, and to employ maximum ingenuity, resourcefulness, and common sense in their utilization.

c. Supply.—The enormous tonnage of engineer supplies required in active operations of any magnitude makes it imperative to limit drastically the number of items to be stocked. Maximum use must be made of standardization and of designs of the utmost simplicity. Local resources should be exploited fully in order to economize transportation still further, especially in moving situations.

d. Decentralization.—Tasks should be laid out in advance and assigned to specific units. The variety and dispersion of engineer tasks usually results in wide dispersion of engineer troops. In such circumstances, best results are obtained by decentralizing responsibility for execution, delegating authority, and encouraging initiative. Control by the commander is exercised and efforts are coordinated by frequent inspections and periodic reports.

e. Reconnaissance.—Systematic engineer reconnaissance is a continuing duty of all echelons. Proper planning cannot be done without it.

f. Security.—All unit commanders are responsible for their own local security, both ground and air. The extent of the security measures taken varies greatly. Important factors are the proximity of enemy forces and the security provided by other friendly troops.

g. Division of work between echelons.—In front-line divisions, engineer work is generally of temporary nature to meet immediate needs. Heavier and more permanent work is executed by engineers of the corps, the army, and the communications zone. Engineers of higher echelons should

follow up closely the engineers of lower units and take over their work as rapidly as possible, so as to permit the lower units to concentrate their efforts on work farther to the front.

■ 18. **FIELD ORDERS.**—Field orders should be issued in time to give all concerned, down to the lowest commanders, opportunity to reconnoiter, plan, and issue any necessary orders to subordinates prior to the hour set for the beginning of the action. Time required for preparation and issuance of orders is affected by the method of issue and the degree of completeness of the order. Clarity is obtained through care in preparation, adherence to a well-understood form and technique, and selection of the best method of issuance. In many cases the manner of preparing and issuing the order is a compromise between the requirements of clarity and speed.

a. Purpose.—Field orders may—

(1) Direct operations.

(2) Warn of impending operations (warning orders). These orders contain advance information so that subordinate units can prepare for coming operations. When a warning order has been given general distribution, matters contained in it need not be repeated in subsequent orders.

b. Methods of issue.—Field orders may be written, oral, or dictated.

(1) Written orders are those prepared and issued in writing. Such orders normally provide the highest degree of clarity but require the most time for preparation. Clarity is enhanced if the copies are delivered to the recipients in the presence of the issuing commander, who then answers all questions relating to the order.

(2) Oral orders are spoken orders issued by the commander usually with the aid of notes. In issuing oral orders, time is not allowed for the recipients to record the order verbatim, but usually each takes notes on the principal points of interest to him. Oral orders save time but may sacrifice clarity; since they depend upon the ear, and to some extent the memory of the receiver. When a typewriter and competent stenographer are available, the possibility of misunderstanding can be reduced if a stenographic record is made of the order as issued. Frequently copies can be

typed and furnished subordinate commanders before they leave the headquarters. This is an excellent method of issuing orders.

(3) Dictated orders are spoken orders issued by the commander and recorded verbatim by the receiver. They provide clarity but require much more time for issuance than oral orders.

c. Complete or fragmentary orders.—Orders may be either complete or fragmentary. Complete orders provide greater clarity and certainty, and promote smoothness of execution; but the time element frequently necessitates the issuance of orders in fragmentary form.

(1) A complete order covers all essential aspects and phases of the operation, and includes missions to all major subordinate units. Such an order is given general distribution.

(2) (a) There are two cases when fragmentary orders normally must be employed. The first and most common case is when the situation develops in such a manner that a complete plan cannot be made at any one time. In such a case the commander develops his plan gradually by partial decisions and places it in effect by fragmentary orders issued to those units whose operations are affected by each decision. As more information is received, the commander makes additional decisions and issues additional fragmentary orders; so that the plan progresses as the action progresses. This procedure is usual in engineer units, particularly in combat engineer units. The second case is when all information necessary for a complete order is known to the issuing commander but certain elements of his command are more urgently in need of immediate orders than others. In this case, the saving of time in issuing fragmentary orders to them must compensate for the resulting delay in issuing orders to other units. Otherwise a complete order is best.

(b) Fragmentary orders should not contain unnecessary information but must contain all that the unit concerned needs to know to carry out its part of the plan until the next phase of the operation. So that all units may have a picture of the operations planned for the force as a whole and thus reduce the possibility of error, it is desirable to confirm as

soon as possible by means of a complete written field order all the orders issued in fragmentary form.

(c) **Fragmentary orders** may be oral, dictated, or written. Usually, however, each one is in the form of a brief written message. The contents are arranged in the sequence in which the same information and instructions would appear in a complete order.

d. Accompanying maps.—The commander normally issues an operation map, overlay, or sketch with an order. This permits brevity and assists in portraying accurately the situation, the plan of the whole unit, and the part each element plays. In many cases, the entire order can be reproduced on the operation map or overlay.

e. Form.—(1) The standard sequence for an order divides it into the heading, grouping of troops (if necessary), body, and ending. The body is divided into five paragraphs as follows, each containing features essential to every complete field order:

1. Information of enemy and friendly troops.
2. Decision and coordinating details of plan applicable to command as a whole.
3. Tactical missions for subordinate units.
4. Administrative matters.
5. Provisions for signal communication, including locations and displacement of command posts.

(2) A detailed explanation of the application of the standard form to combat operations is given in FM 101-5.

f. Application of five-paragraph order to engineer operations.—With minor changes the standard five-paragraph field order is used for engineer operations.

(1) *(a) Paragraph 1a.*—Includes information of enemy which may affect the engineer unit. When an engineer unit is operating in rear areas the possibility of enemy aerial attack, mechanized raids, and fifth-column activities are included.

(b) *Paragraph 1b.*—Includes information as to friendly units. May be subdivided into three subparagraphs. The first gives information of location and operations of troops of next higher unit. The second covers the same for adjacent troops. The third includes information of special engineer value to the command as a whole; for example, a

weather forecast or information as to the security which is to be provided by other forces.

(2) *Paragraph 2.*—Gives briefly the decision. It should answer the questions: *what, how, when, and where.*

(3) *Paragraph 3.*—Assigns, in subparagraphs, a definite mission to each major subordinate unit. For example the 1st Battalion may be charged with barriers and obstacles in a definite area on the flank while the 2d Battalion may be made responsible for the maintenance of routes of communication in another prescribed area. Subparagraph *x* gives any order applicable to two or more subordinate units. It may include such duties as engineer reconnaissance, engineer supply functions for the division, corps, or army, and limitations on movement of troops. Many subjects included in paragraph 3 of the engineer order would be included also in paragraph 4 of the field order of the higher unit or in the administrative order of that unit. This is because functions such as road maintenance, which are administrative in nature on the part of the higher unit, are operational for the engineer unit.

(4) *Paragraph 4.*—Includes only administrative and supply details necessary for internal operation of unit.

(5) *Paragraph 5.*—Lists command posts of unit and of major subordinate units. The axis of signal communication usually is omitted, as the command post of the unit follows closely that of the higher unit, or, as in rear areas, remains relatively fixed.

■ 19. ADMINISTRATIVE ORDERS.—Administrative orders cover supply, evacuation, and other administrative details of units of the combined arms. They are issued when the instructions regarding these matters are too voluminous to be placed in paragraph 4 of the field order, or when a field order is not being issued at the moment when it becomes necessary to issue administrative instructions. Administrative orders may be oral, dictated, or written, and in either complete or fragmentary form. Administrative orders within an engineer unit usually are issued orally and in fragmentary form.

■ 20. TECHNIQUE OF ORDERS.—*a. Amount of detail.*—Orders should be concise. Those giving missions for subordinate

units should prescribe only such details or methods of execution as are necessary to insure that the actions of the subordinate unit will conform to the operations of the force as a whole. In many cases, brevity is governed by the state of training of the troops; for a newly organized or poorly trained unit, the orders of necessity must be more detailed than for a well-trained organization. It must be the constant aim of all commanders to strive for the utmost brevity in orders.

b. Boundaries.—Boundaries delimit zones of action or movement and areas of responsibility. If possible, they are designated in orders by easily identified landmarks. Boundaries should not divide key terrain features, such as hills, crossroads, and villages; these should be made the responsibility of but one unit. Boundaries are designated from rear to front or from right to left.

c. Details of time.—(1) Dates include the day, month, and year, thus: 4 Aug. 40. In stating a night, both dates should be included, thus: night 4-5 Aug. 40.

(2) When the date and hour are indefinite, D-day and H-hour may be used, and the selected date and hour communicated later to those concerned.

(3) The 24-hour clock system is used. In this system four numerals are given, the first two indicating the hour, and the last two the minutes after the hour. Six numerals may be employed, the first two indicating the day of the month. In large units it may be preferable to refer time to that at a predetermined location. Greenwich Mean Time is used for this purpose and the prefix Z is used to indicate it.

Examples:

12-hour system	24-hour system
12:01 AM-----	0001
7:05 May 6-----	060705
Noon, Greenwich Mean Time-----	Z1200
7:35 PM-----	1935
Midnight-----	2400

d. Details of place.—(1) The use of the principal compass points to designate direction is preferable to the terms "right" and "left." When right or left is used, the user is assumed to be facing the enemy, except that the right or left flank of an enemy unit is designated with reference to its own

front. The right or left bank of a stream is that of an observer facing down-stream.

(2) Places or features should be identified by giving their coordinates, or by stating their location in relation to some more easily distinguishable feature or place on the map, as "1 mi. west of Clarkson."

(3) Roads are identified by name or by a sequence of points on the road, named in the direction of movement. When there is no movement, roads are designated from right to left or rear to front, assuming that the person designating the road is facing the enemy.

(4) Areas are designated by naming, counterclockwise, a suitable number of points delimiting them. The first point so named, regardless of whether the area pertains to friendly troops or to the enemy, is one on the right front from the viewpoint of our troops.

e. Use of terms.—Terms which lessen responsibility such as "try to construct" and "destroy if possible," and those which do not accurately state a time, such as "at daylight," "at dark," and "as soon as possible," are avoided in orders.

f. Abbreviations.—Authorized abbreviations are given in FM 21-30. Unfamiliar abbreviations, even though authorized, should not be used unless an explanatory legend is included.

g. Affirmative.—The affirmative form of expression should be used. Such an order as "Trains will not accompany regiment" is defective because if the word "not" is lost in transmission exactly the opposite of the desire of commander will be carried out. A better form is "Trains will remain at Sedan." If words are lost from this message it will not give erroneous instructions.

h. Designation of units.—The numerical designation of an army is spelled out in full, as "First"; that of a corps is given in roman numerals, as "II"; and that of a division or smaller unit in arabic numerals, as "3d."

i. Avoidance of highly technical language.—In combat orders it is essential that there is no opportunity for misunderstanding by any subordinate of the exact intended meaning of all terms used. Therefore clear, concise language only must be used and technical expressions should be avoided if there is any danger of misunderstanding.

■ 21. ORDERS OF HIGHER UNITS.—The unit engineer controls the operations of the engineers of his unit, and specific orders for him to do so are not necessary. Instructions for engineers which appear in higher orders are primarily for the information of other units of the command, and normally are prepared by the unit engineer. They may be incorporated as subparagraphs of the unit field order or annexes to it or as subparagraphs of the unit administrative order or annexes to it, depending on the nature and extent of the instructions issued. Seldom will such instructions be included as annexes to both the field and administrative orders.

a. Engineer paragraphs of field order.—(1) The tactical mission and disposition of the engineers are given in a subparagraph of paragraph 3 of the field order of larger units. In a division field order, this may cover attachment of engineers to tactical echelons, employment of engineers in organization of the ground, use of engineers as combat reserve, assignment to obstacle or demolition missions, or use of engineers in operations involving river crossings. The subparagraph is generally brief, except in the case of river crossings.

(2) The major portions of the engineer mission frequently are administrative matters, from the viewpoint of the higher unit. Therefore they are included in paragraph 4 of the field order, instead of in paragraph 3. In divisions and larger units, when such engineer instructions are voluminous, they are placed in the administrative order and amplified if necessary by an annex (see *d* below).

(3) Other subparagraphs, such as those in paragraph 3*x* dealing with demolitions or organization of the ground and those in paragraph 4 dealing with traffic circulation, usually are prepared by the unit engineer on request from the general staff or as standing operating procedure.

b. Engineer annexes to field order.—When the plan for the tactical employment of engineers involves detail too great for inclusion in paragraph 3 of the unit field order, it may be added as an annex; for example, a detailed plan for tactical employment of engineers in a river crossing may be so treated. This annex is given a number and an appropriate title such as: "Annex 5 to FO 10, Engineers." Such an annex has the full force of the order and serves to inform other

commanders of the missions assigned to the engineers. It is prepared by the unit engineer and his staff, subject to approval of the general staff.

c. Engineer paragraphs of unit administrative order.—In divisions and larger units, paragraph 4 of the field order usually consists of a reference to an administrative order. The unit engineer is concerned with those parts of the administrative order that cover engineer operations and normally prepares these for the general staff.

d. Engineer annexes to unit administrative order.—In units larger than the division, a numbered annex to the administrative order may be issued. This annex is usually either a copy of the engineer order issued by the unit engineer or a brief statement of the engineer part in the operation. It gives information necessary for the other arms and services. It is prepared by the unit engineer.

■ 22. BULLETINS AND REPORTS.—*a.* The unit engineer prepares documents necessary to keep his troops informed of the engineer situation and such reports as may be required by the unit commander or higher authority.

b. Engineer bulletins which also record information of value to the unit commander, are the principal means of keeping troops informed of the engineer situation. Engineer situation reports include information concerning the disposition and employment of subordinate engineer units as of a definite time or over a definite period, and supply information needed for inclusion in situation reports of the higher unit. Engineer information reports are similar to engineer bulletins but are more complete. Such reports frequently are referred to in the engineer field order, or are made annexes to it.

c. In addition to these periodical bulletins, the unit engineer makes reports as required by the unit commander or his staff, and by the unit engineer of the next higher echelon.

■ 23. STANDING OPERATING PROCEDURE.—The commander of every unit should prescribe a standing operating procedure (SOP). It renders more specific the instructions contained in War Department publications by standardizing certain elements of operations to fit conditions peculiar to a unit at a particular time. These instructions are complied with

by all elements of the unit without further instructions except when they are superseded by specific orders. The SOP of a unit is published as a standing order; but to continue being effective it must be revised frequently to include changes necessitated by changes in command, geographical locality, time of year, type of operation, or development of improved methods.

a. Purpose.—The purpose of the SOP is to contribute to success in battle by minimizing confusion and delay in the execution of field operations. In order to accomplish this purpose, the provisions of the SOP must—

(1) Promote understanding and teamwork between commander, staff, and troops.

(2) Simplify and abbreviate combat orders, expedite their transmission, and eliminate confusion and delay in their interpretation.

(3) Provide for training troops in a single method of conducting various kinds of operations or in a limited number of alternate methods so that these operations can be performed smoothly and efficiently without orders or with abbreviated orders.

b. Use.—Every engineer unit should develop its own standing operating procedure, subject only to instructions from higher authority. For various units these will not be the same, since each one reflects the policies and methods of its own commander and of the next higher commander. The SOP should be written and published so as to be available to and clearly understood by all elements of the command. Each man should be so familiar with those parts referring to him that he will be able to carry them out without consulting the order.

c. Scope.—An SOP should be so brief and clear that its contents can be read, understood, and remembered by all personnel. A bulky SOP defeats its purpose. All unnecessary repetition of procedures prescribed in War Department publications should be avoided, though in some cases repetition may be desirable for emphasis. Administrative matters not important to field operations should be published in a separate standing order; but those which are important to field operations are included in the SOP. Details such as standard

loading charts and radio procedure may be included as annexes.

d. Contents.—Suggested outline for an SOP:

(1) *Command, staff, and liaison.*—(a) Allocation of command and staff duties.

(b) Instructions for establishment and location of command posts.

(c) Provision for additional messengers from lower headquarters and to higher and adjacent units.

(d) In the case of division engineer units, engineer allotments to combat teams.

(2) *Administration.*—(a) Composition and duties of unit personnel section.

(b) Distribution and collection of mail.

(c) Disposition of prisoners of war.

(d) Evacuation of wounded, including location of aid stations and provisions for extra litter bearers.

(3) *Movement.*—(a) Types of movement.

(b) Order of march.

(c) Speed and intervals.

(d) Traffic control.

(e) Halts.

(f) Refueling and inspections.

(g) Actions in case of disabled vehicles.

(h) Advance details (quartering parties).

(4) *Security.*—(a) Responsibility for security of working parties.

(b) Motor columns.

(c) Troops in bivouac.

(d) Actions in case of air attack.

(e) Warning systems and signals.

(f) Antimechanized measures.

(5) *Communication.*—(a) Normal procedure for message centers.

(b) Methods of communication, and when each is used.

(c) Identification of messengers.

(d) Radio procedure.

(6) *Intelligence and reconnaissance.*—(a) Formations, composition, and functions of special reconnaissance parties with unit and in subordinate units.

(b) Type of information sent back by details attached to other troops, and methods of transmittal.

(c) Type of information included in periodic reports.

(d) Type of information to be reported at once.

(e) Counterintelligence measures.

(7) *Supply*.—(a) Procedure for obtaining various classes of supply.

(b) Procedures for supplying engineer materials to other troops.

(c) Water supply.

(8) *Organization for combat*.—(a) Division of unit into forward and rear echelon.

(b) Care of vehicles and other equipment not needed for combat.

(c) Plans for carrying on necessary engineer work.

(9) *Appendix*.—(a) Prearranged codes to simplify signal communication.

(b) March tables.

(c) Vehicle loading diagrams.

(d) Information for particular units which is not of value to unit as a whole.

CHAPTER 3

ENGINEER INTELLIGENCE AND RECONNAISSANCE

■ 24. GENERAL.—*a. Purpose and scope.*—This chapter describes the process by which information of special value to military engineers is collected and made available for use in connection with engineer plans and orders. It includes a discussion of the fundamentals of reconnaissance; the organization provided within engineer headquarters for supervision of all operations for producing intelligence; the intelligence plan; the planning, conduct, and preparation of reports on reconnaissance; and the processing and dissemination of the resulting information.

b. Definitions.—(1) *Engineer reconnaissance* is the operation of searching for engineer information in the field.

(2) *Engineer information* includes information on the topography and resources of the area in which operations are being or may be conducted, and information of enemy installation and activities which affect engineer operations.

c. Relation between engineer reconnaissance and intelligence.—Engineer reconnaissance is the most important and reliable source of engineer information. In small engineer units, information resulting from engineer reconnaissance normally must be made the basis of engineer plans and orders without further verification. In engineer battalions, regiments, and higher headquarters such information is evaluated with regard to accuracy and adequacy, classified, and studied in connection with related information obtained from other sources before being used. Engineer information so processed becomes *engineer intelligence*.

■ 25. FUNDAMENTALS OF ENGINEER RECONNAISSANCE.—*a. General.*—Fundamentals governing engineer reconnaissance are:

(1) It is a responsibility of all engineer commanders.

(2) Reconnaissance normally precedes other engineer operations but should not delay them. It must be completed in time to permit necessary planning and preparation before

execution of engineer work. In combat, speedy, accurate reconnaissance is of vital importance.

(3) Information sought includes both that necessary for a unit's own operations and that required by higher authority.

(4) Reports of reconnaissance sent to higher authority must arrive in time. Timely but incomplete information is valuable but complete information received too late is worthless.

(5) Reconnaissance is a continuing function and must be repeated as often as necessary.

(6) Reconnaissance forces are given missions in accordance with their capabilities.

(7) Reconnaissance forces engage in combat only to the extent necessary to gain the required information.

b. Types.—Engineer reconnaissance may be general or special.

(1) *General reconnaissance* is to secure engineer information of a general nature in a given area. It is limited in its detail only by the time and capabilities of the personnel making the reconnaissance. The kind of information especially sought should be specified in orders. It varies with the activity in which the unit is engaged.

(2) *Special reconnaissance* supplements general reconnaissance. It is made to secure detailed information concerning a specific object such as a bridge, or for a special purpose. Instructions for the conduct of special reconnaissances and typical forms for rendering reconnaissance reports are included in appropriate sections of the Field Manuals indicated below:

<i>Type of reconnaissance</i>	<i>Reference</i>
Roads and bridges.....	FM 5-10
Defensive positions.....	FM 5-15
Camouflage.....	FM 5-20
Demolitions.....	FM 5-25
Mine fields.....	FM 5-30

■ 26. ECHELONS OF ENGINEER RECONNAISSANCE.—*a. Air.*—The most advanced engineer reconnoitering elements consist of engineer personnel accompanying the air forces, or of air

force elements assigned engineer reconnaissance missions.

b. Advance ground.—The most advanced ground engineer reconnaissance usually is made by engineer units with armored forces or mechanized cavalry. Engineer reconnaissance is one of the most important missions of these units. The scope of this reconnaissance is broad, embracing not only operations of these advanced forces but also the entire engineer situation in the area.

c. Division areas.—In the division areas, the work of engineer reconnaissance is executed mostly by elements of the division engineer battalion. It is planned and supervised by the engineer intelligence officer, whose duties are outlined in paragraph 27b.

d. Rear areas.—Continuous engineer reconnaissance of corps and army areas and of the communication zone is planned and supervised by the respective unit engineers. Close liaison is maintained with unit engineers in adjacent areas and in the forward zone. In an advance, this liaison is especially important, and rapidly changing conditions sometimes necessitate frequent reports from liaison officers with forward echelons.

■ 27. ORGANIZATION OF ENGINEER HEADQUARTERS FOR COLLECTION AND DISSEMINATION OF ENGINEER INFORMATION.—*a. Unit commander.*—(1) Since intelligence constitutes a vital element of the commander's estimate of the situation and continually affects his decisions and orders, it is a basic function of command to initiate and coordinate the search for information from which the intelligence is derived. In addition, a commander may be given reconnaissance missions by higher authority which may or may not coincide with his own requirements for information. In any case, each commander is charged with the collection of military information within his zone of operations for the use of his own and higher headquarters. The general responsibilities of commanders with respect to reconnaissance are outlined in FM 100-5.

(2) An engineer commander often personally carries out engineer reconnaissances of critical importance. In other cases he usually intrusts reconnaissance missions to officers

and units of his command. An engineer commander of a small unit such as a company or platoon normally makes a personal reconnaissance before every operation. Commanders of battalions and regiments make personal reconnaissances of a general nature but usually delegate detailed reconnaissance to their subordinates.

b. Intelligence officers.—Commanders of engineer battalions and of higher engineer headquarters have on their staffs intelligence officers. These officers assist the commander in initiating, supervising, and coordinating the search for engineer information and in evaluating, correlating, and disseminating that information. In smaller engineer units this work is normally done by the unit commander with some assistance from the enlisted personnel of his headquarters. In the execution of his duties the intelligence officer conforms in general to the instructions contained in FM 30-5. He maintains adequate intelligence records and a situation map. His detailed duties with regard to engineer intelligence are listed below.

- (1) Specify information to be gathered.

- (2) Initiate systematic and coordinated search for required information by all available collecting agencies. (In making plans for reconnaissance, it is essential that the operations officer, S-3, be consulted with regard to the use of troops and that the reconnaissance plan be coordinated with plans for the conduct of other engineer operations.)

- (3) Evaluate and interpret information obtained from all possible sources.

- (4) Reduce resulting intelligence to systematic form and distribute it as necessary.

- (5) Maintain close liaison with intelligence sections of higher, lower, and adjacent units.

- (6) Exercise general supervision over all intelligence activities of the unit, including intelligence training.

- (7) Act as map supply officer for his unit and, in some cases, for the larger unit of which his unit is a part.

c. Other staff officers.—S-1, S-3, and S-4 utilize personnel assigned to their staff sections to conduct special reconnaissance to obtain information directly connected with

their activities. Such reconnaissance is coordinated by S-2 to eliminate duplication of effort, and information gained by them is reported to S-2. In each division the assistant division engineer keeps a record in division headquarters for use of the division staff showing all engineer intelligence produced by the engineer battalion.

■ 28. INTELLIGENCE PLAN.—*a. General.*—The engineer intelligence plan should orient and focus the search for information so as to secure all essential information with the greatest speed and economy of force. The intelligence plan indicates what information is most important and by what means it is to be obtained.

b. Elements of information.—Elements of information for the unit intelligence plan include not only the information required for planning operations of the engineer unit but also that required by higher units. Determination of the elements cannot be made without a thorough understanding of the tactical situation and the expected employment of engineers. Elements of information change with the situation and must be restated as often as necessary.

c. Means of securing information.—The principal sources of information for an engineer unit are:

- (1) Reconnaissance by engineer elements.
- (2) Study of military maps and photographs, both aerial and ground.
- (3) Liaison with other troops, such as advanced cavalry and infantry units.
- (4) Questioning of civilians and prisoners.
- (5) Information obtained from headquarters of higher units.
- (6) Information obtained from unit engineers of higher headquarters and adjacent units.
- (7) Information obtained from local sources, such as libraries and offices.

d. Model form.—A model form for an intelligence plan of a division combat battalion is given in table I. Its use will guard against omission of important details. The form lists separately the information to be sent immediately to higher

headquarters. This form with minor changes is suitable for higher engineer units.

■ 29. RECONNAISSANCE INSTRUCTIONS.—Orders for a reconnaissance should be clear and complete and should contain instructions as to when and where reports are to be submitted, and what type they are to be. Orders for a general reconnaissance should specify the area to be reconnoitered and items of information which are considered particularly important. A model form for reconnaissance instructions is generally used to expedite issuance of such instructions and to guard against errors of omission, especially in the case of inexperienced personnel. Table II shows such a form. Item 1 on this form covers general reconnaissance features. All other items are listed alphabetically. On the reverse side of the form are road and bridge symbols to be used in the reconnaissance report.

■ 30. CONDUCT OF RECONNAISSANCE.—*a.* A reconnaissance should always be preceded by a brief study of the reconnaissance mission, time limitations, and map or photographs immediately available. The person going out must know what he is looking for, how much detail is expected, and the relative importance of the different items of information desired.

b. A reconnaissance must be conducted in such a manner as to permit the submission of a report at the required place at the time specified.

TABLE I.—*Model intelligence plan*
ENGINEER INTELLIGENCE (S-2) PLAN
Period: 1400 2 May to 0600 3 May, 1940

Essential elements of information announced by division commander:

1. Will enemy attempt to cross Monocacy River tomorrow?

2. Where will main effort be and what secondary attacks will be made?

3. What will his strength be at time of attack?

Agencies to be employed.

Information required	Request G-2	Request corps engineers	S-2	S-3	S-1	Company A	Company B	Company C
TO BE FURNISHED IMMEDIATELY TO DIVISION OR OTHER HEADQUARTERS								
1. Sites suitable for ponton bridges, foot-bridges, ferries, and assault boats				X				
2. Detailed information on roads leading from river on our side and lateral roads in our defense zone						X	X	X
3. Detailed information on roads leading to river on enemy side	X		X					
4. Cover and concealment on both sides of river	X		X	X		X	X	X
5. Location of supply points for dumping fortification materials for use in organizing our defensive position					X			
6. Location of defensive positions to the rear of the selected battle position				X				
PRIMARILY FOR USE BY ENGINEER BATTALION								
7. Location of engineer materials in zone of each infantry regiment						X	X	X
8. Location of other engineer materials		X			X			
9. Location of positions for construction of road blocks within our position				X		X	X	X

TABLE II.—*Model reconnaissance form*
(Front)

RECONNAISSANCE INSTRUCTIONS

No. -----
 To -----
 Effective -----
 Maps -----
 Complete report to be submitted to ----- at ----- by -----
 hours ----- unless otherwise noted under DETAILED INSTRUCTIONS.

Reconnoiter and report information as indicated below by items checked. Report also any other information of technical importance incidentally secured

DETAILED INSTRUCTIONS
 Areas and roads to be reconnoitered in connection with missions ordered

1. GENERAL FEATURES (complete report with particular attention to other items checked).
2. ADVANCED LANDING FIELD.
3. ADVERSE ENGINEER SITUATION IN CONNECTION WITH ENGINEER UNIT ATTACHED (column delayed, insufficient supplies, insufficient engineers attached, etc.).
4. AVENUES OF APPROACH.
5. BRIDGES (to be reported using code on reverse of these instructions).
6. BIVOUAC AREAS (suitable for a battalion or larger unit; give details on availability of entrances, exits, water concealment).
7. DEFENSIVE POSITIONS.
8. DEMOLITIONS BY ENEMY (details; labor, materials, and time necessary to repair).
9. ERRORS IN EXISTING MAPS.
10. MATERIALS AND PLANT (including captured enemy material).
11. OBSTACLES TO OUR MOVEMENT (natural and artificial—including mines and booby traps).
12. OBSTACLES TO ENEMY MOVEMENT (suitable points).
13. RAILROADS.
14. ROADS (to be reported using code on reverse of these instructions).
15. STREAMS (width, depth, fords, ferries, condition of banks and approaches, potability).
16. UTILITIES (garages, machine shops, electric plants, water-supply plants, gas systems).
17. WATERWAYS (usable depth, floating plant).

By order of -----
 (Signature)

 (Grade and organization)

(BACK)

Road information shown on map or overlay accompanying report applies throughout the length of road between points shown by heavy dots or crossbars. The characteristics of roads and bridges are indicated by the following symbols:

a. General road types.

Physical characteristics	Type of surface		
	All-weather		Earth
	Paved; such as concrete, bituminous, brick, or other pavement	Improved; such as gravel, crushed rock, stabilized soil, select granular material, or other wearing material ¹	Unimproved; dusty when dry, muddy when wet
Good road (gentle grades, gradual curves, smooth surface, good foundation)-----	A	C	E
Poor road (steep grades, sharp curves, rough surface, or poor foundation)--	B	D	F ²

¹ Includes roads of these materials treated with a dust palliative or covered by a bituminous surface treatment or seal coat.

² Probably impassable in wet weather.

b. General characteristics of roads and bridges.(1) *Traffic lanes.*

1, 2, 3, etc. Placed after road-type symbol to indicate roadways suitable for continuous traffic in one, two, three, etc., lanes, respectively.

1+ One-lane roadway having occasional passing locations, and suitable for very light two-way traffic.

1½ One-lane roadway having frequent passing locations, and suitable for light two-way traffic.

2— Two-lane roadway having occasional one-lane defiles, and suitable for moderate two-way traffic.

(2) *Information.*

W Followed by numeral indicates clearance width in feet provided at most critical location. Symbol is preceded by numeral to indicate number of such lanes (for example, 2 W 9 indicates two separate lanes, each of which provides a clearance width of 9 feet).

H Followed by numeral indicates clearance height in feet between surface of roadway and overhead obstruction.

T Preceded by numeral indicates tonnage limitation (bridges).

Mi Preceded by numeral indicates distance in miles.

I Followed by numeral indicates average interval of time (time-distance) in minutes required by motor vehicles during daylight to travel section of road shown.

c. *Engineer characteristics of roads and bridges.*(1) *Roads.*

Concrete	k
Bituminous pavement, heavy duty	bt
Brick or block pavement	br
Bituminous surface treatment (except on concrete, brick, or block pavement), bituminous stabilized sand or gravel, or other bituminous type not suitable for heavy duty	bs
Crushed rock or macadam	m
Gravel	g
Stabilized soil, sand-clay, shell, cinders, dis-integrated granite, or other select material	sm
Earth	ea

(2) *Bridges.*

Concrete, slab or beam	k
Concrete arch	ka
Steel beam	sb
Steel truss	st
Steel girder	sg
Stone arch	sa
Wood trestle	wo
Wood truss	wot

Length..... l
 Height above stream bed..... ht
 Panel length (trusses)..... p
 Condition—state as “excellent,” “good,” “fair,”
 or “poor.”

When an area is to be covered, a schedule should be made out quickly and adhered to. It should include the routes to be taken and a time schedule. Sufficient time should be reserved at the end to prepare a clear report.

c. Security must be considered in planning and conducting a reconnaissance. In forward areas, the number and size of reconnaissance parties may be restricted for reasons of secrecy. Parties should seek concealment from ground and air observation not only for their own protection but also to withhold information of reconnaissance activity from the enemy. In forward areas motorized reconnaissance parties should consist of two or more vehicles proceeding as a motorized patrol as described in section II, chapter 4. An officer engaged in important reconnaissance in forward areas should always be accompanied by another person who can report to higher authority promptly if the officer becomes a casualty. This often saves serious delays.

■ 31. REPORTS.—a. *General.*—The results of a reconnaissance are embodied in a brief written report. As far as possible, information is presented graphically or in tabular form. The value of the report is enhanced by photographs and by the use of the proper symbols on a map or overlay. The date and hour, and the name and grade of the person making the reconnaissance are included.

b. *Material, time, and labor estimates.*—When time permits, reconnaissance reports must include brief estimates of time, labor, and amounts of material required for probable engineer operations. This estimate is particularly important for reconnaissance of roads, bridges, and other stream crossings. A reconnaissance report for a bridge demolition task should also include an estimate of time for reconstruction of the bridge after it has been destroyed. This information is a measure of the probable delay which will be caused the enemy by the demolition.

c. Fragmentary reports.—Standing operating procedure and reconnaissance orders often specify that certain types of information are to be reported at once by the fastest available means. Whenever possible such information is reported by radio, using simple prearranged codes. In any case communication means should be provided by which such reports when required can be rendered without seriously delaying the completion of other important reconnaissance missions.

d. Blank forms.—(1) Printed blank forms frequently are used for technical reconnaissance and reconnaissance reports. Because of the variety of situations encountered in the field, forms cannot be prepared in advance which will cover all situations, nor can they replace practical reconnaissance training and definite instructions for each situation.

(2) A properly prepared form guards against the omission of important details from the report, and facilitates the compilation of information.

(3) All forms should provide for listing the date and time, reconnaissance party, maps used, area covered, and signature, grade, and organization of leader of party. In addition, each type of reconnaissance requires the gathering of special information. The following check lists may be used as guides for some of the common type of engineer reconnaissance.

(a) Route reconnaissance.

1. Route followed.
2. Route number.
3. From.
4. To.
5. Type and condition of road, shown by symbols indicated on reverse side of reconnaissance instructions form. (See table II.)
6. Repairs needed (location; time, labor, and material estimate; whether or not materials are near site).
7. Load capacities and condition of bridges (repair data).
8. Other critical points (location, nature, repair data).

(b) Bridge reconnaissance.

1. Location.
2. Width and depth of stream and condition of banks and bottom.

3. Bridge data (shown by symbols indicated on reverse side of reconnaissance instructions form).
 4. Repairs needed for required loads (time, labor, and material estimate and whether or not materials are near site).
 5. Demolition data (time and labor estimate and materials needed).
 6. Effectiveness of proposed destruction (estimate of time and labor necessary to effect a crossing after demolition).
- (c) *Reconnaissance of towns.*
1. Name.
 2. Location.
 3. Population.
 4. Water, gas, and electricity (existence, condition, and capacity).
 5. Billets (number of troops that can be accommodated).
 6. Machine shops and other plants (existence and condition).
 7. Engineer supplies (especially hardware stores and lumber yards).
 8. Communication (roads, railroads, sidings, etc.)
 9. Airfields.
- (d) *Reconnaissance for supplies and equipment.*
1. Location.
 2. Type of materials.
 3. Quantity, including bill of materials when applicable.
- (e) *Reconnaissance for barrier zone.*
1. Principal natural obstacles.
 2. Ground favorable for mechanized fires.
 3. All roads and trails.
 4. All sites suitable for construction of road blocks.
 5. Estimate of time, labor, and materials necessary for construction of a road block at each site.
 6. Location of local materials available for construction of road blocks.
 7. Size of garrison necessary to cover obstacle at each site with fire.

3. Availability of covered routes suitable for rapid withdrawal of garrison at each site.

(f) *Water reconnaissance.*

1. Location and description of existing sources, including quality and yield and equipment available at each.
2. Data on underground sources gained from inhabitants and local records.

(g) *Railroad reconnaissance.*

1. Local name of railway.
2. Terminal points and distances between stations.
3. Gage.
4. Track—whether single, double, or multiple.
5. Condition of roadbed, ties, and rails.
6. Ruling grade and maximum curvature.
7. Number, length, and location of passing tracks.
8. Location of grade crossings.
9. Drainage and liability to overflows or washouts.
10. Facilities for repair.
11. Condition of right-of-way for marching troops along the line.
12. Number, location, dimensions, and strength of tunnels and bridges.
13. Number and nature of engines and cars.
14. Available capacity for transporting troops and supplies between given points.
15. Location and capacity of shops and store yards.
16. Name and location of stations with facilities for entraining and detraining troops.
17. Sidings and capacities.
18. Platforms.
19. Ramps.
20. Turntables.
21. Water tanks.
22. Fuel supply.
23. Storage facilities.
24. Derricks and cranes.
25. Signal communication.
26. Repairs needed because of enemy demolitions.

■ 32. RECONNAISSANCE TRAINING.—*a. Individual.*—Special training is necessary to insure that officers, noncommissioned officers, and selected privates will be able to conduct engineer reconnaissance with efficiency and submit adequate and timely reconnaissance reports. Training of individuals in reconnaissance should emphasize—

- (1) Importance of time element.
- (2) Ability to move rapidly by various means and under adverse conditions.
- (3) Familiarity with engineering structures.
- (4) Ability to make rapid calculations of capacity of structures and of quantities of material required or available.
- (5) High standards of performance in map reading and sketching.
- (6) Expertness in rapid preparation of written and oral messages and reports.
- (7) Adeptness in scouting and patrolling methods necessary to avoid opposition and secure information by stealth.
- (8) Familiarity with enemy uniforms, combat equipment, and obstacles.

b. Unit.—In addition to training of individuals to insure efficient conduct of reconnaissance and reporting of information gained, it is essential that the training of the unit include all necessary provisions for speedy initiation of reconnaissance and in processing and disseminating the information gained. Such provisions include the following:

- (1) Prompt notification of the unit engineer of prospective plans of operation.
- (2) Alerting engineer reconnaissance elements when need for their employment is foreseen.
- (3) Adequate transportation, equipment, and means of communication for reconnaissance parties.
- (4) Precise reconnaissance instructions.
- (5) Special forms, map symbols, and codes for reporting results of reconnaissance.
- (6) Draftsmen and other personnel trained to receive reconnaissance reports and put them in proper form for transmittal.
- (7) Communication means for prompt dissemination of information.

■ 33. SOURCES OF ENGINEER INFORMATION OTHER THAN ENGINEER UNITS.—*a. General staff.*—The intelligence section (G-2) of theater headquarters furnishes subordinate headquarters with much military intelligence concerning the terrain and enemy. This intelligence, supplemented whenever possible, is passed down to lower intelligence staffs. It includes topographic maps and data concerning the physical characteristics of the country, its economic development, transportation routes and facilities, railway and highway data (including design of bridges, tunnels, and terminals), general construction methods and equipment, enemy engineer organization and equipment, general engineer supplies, and utilities. All of this information is needed as an aid to engineer reconnaissance. G-2 also furnishes interpreters to assist in examination of prisoners.

b. Air forces.—Aviation is a valuable agency for speedy and extensive reconnaissance of a general nature; it is also capable of securing detailed information, particularly through aerial photography. Much valuable engineer information can be secured by aerial reconnaissance, especially with regard to river lines, condition of roads and bridges, and location and types of enemy obstacles. Aerial reconnaissance may also be used to advantage in checking the efficiency of our camouflage operations. Engineer officers are trained in interpretation of aerial photographs, and in aerial observation whenever possible. Proper aerial engineer reconnaissance requires trained engineer observers, but aerial photographs are made by air force personnel.

c. Mechanized cavalry and armored units.—Reconnaissance elements of armored units and mechanized cavalry normally gather engineer information as to location and general condition of roads and bridges, existence and types of enemy obstacles, location and character of stream, and major sources of engineer supplies. Much of this information is not included in initial reports to higher headquarters and therefore can be secured by engineers only by direct liaison with the units making the reconnaissance.

d. Infantry.—Infantry frequently gain valuable engineer information before it is known to troops of other arms. This is especially true in an attack. Close liaison with in-

fantry units may result in considerable saving of time in initiating construction or repair of bridges and in initiating engineer operations to clear mine fields or other obstacles. This liaison is especially necessary in assembling the information on enemy obstacles and fortifications which is necessary when planning an assault on a fortified locality.

e. Artillery.—Problems connected with roads and bridges are of the utmost importance to the artillery, and much valuable information on these matters may be exchanged between artillerymen and engineers. Artillery observers in command posts and in the front line are in a position to note enemy obstacles and preparations for destruction of lines of communication or the extent of destruction already accomplished. They also observe and record errors in existing maps. Liaison should be established to provide for the prompt transmission of such information.

f. Medical Corps.—Medical personnel will conduct field laboratory tests of water sources to determine their purity. Such information guides engineers in their reconnaissances for water supply.

■ 34. EVALUATION AND DISSEMINATION OF INFORMATION.—*a.* Reconnaissance reports are military information but not military intelligence. Within small units such as companies and platoons, the military information gathered by reconnaissance parties is collected and consolidated into a report of reconnaissance of the unit as a whole. Such consolidated information is transmitted to higher headquarters. When it reaches regimental or battalion headquarters, the intelligence officer classifies it so that items of the same character are grouped together; he then compares, analyzes, evaluates, and interprets the available information. The result constitutes military intelligence, which is promptly disseminated, in accordance with its urgency, to appropriate elements of the engineer unit and to higher unit and engineer headquarters. The intelligence is disseminated by personal contact or telephone conversation; by special messages sent by airplane, motor vehicle, radio, or other means; by conferences between the intelligence sections of higher, lower, and adjacent units; and by routine intelligence reports.

b. Reports covering the current status of engineer information may be required of the unit engineer at stated periods or at irregular intervals. When they are rendered regularly, it is advisable to maintain a work sheet for each separate paragraph of the report. On these sheets the information applicable to each portion of the report is entered as soon as it is received and evaluated, the sheets being held open for entry of data until the hour for drafting the report in its final form.

CHAPTER 4

COMBAT OPERATIONS

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SECTION I

EMPLOYMENT OF ENGINEER UNITS FOR DISMOUNTED COMBAT

■ 35. GENERAL.—*a. Combat engineer troops.*—(1) In carrying out their mission, engineers may become involved in combat. They may participate actively in defense against airborne and mechanized troops, in the defense of road blocks and mine fields, in tank hunting, and assist by demolition in the passage of hostile obstacles and the capture of fortified localities. Often they are forced to fight to maintain their own security while on the march, in bivouac, or at work. In combat of the nature outlined above, engineers may fight in small units—a squad or less, a platoon, or occasionally, a company. They should be trained thoroughly in the use of their weapons and in infantry tactics.

(2) In an emergency, engineers with a division may be relieved of their engineer work and used for combat. In such case the decision must be weighed carefully by the division commander, as the cessation of engineer work may result in a loss of mobility for the division and thus a reduction in its total combat power not compensated for by the use of engineers as infantry.

(3) This section describes the organization and employment of engineer units for combat in the execution of missions normally performed by infantry. Succeeding sections describe combat operations of engineers in providing for the security of their own and larger units, in defense of obstacles and barriers, in passage of artificial obstacles, and in assault of fortified localities.

b. Aviation engineer troops.—Aviation engineer troops are equipped and trained for combat primarily so that they may assist in the defense of airdromes. They may be used to defend the airdrome itself against hostile airplanes, parachutists, airborne troops, and ground raids, or to attack any force that may have established itself nearby.

c. Other engineer troops.—Other general and special engineer troops should be trained to provide their own local security when at work, in movement, or in bivouac, and to assist in the defense of rear installations when they are subjected to sudden airborne or mechanized attack.

d. Basic tactics.—The basic tactics of engineers when engaged in combat are the same as those of infantry. (See FM 7-10 and 7-20.)

■ **36. GENERAL ORGANIZATION FOR COMBAT.**—*a. Modification of normal organization.*—When employed in combat either in furnishing their own security during engineer missions or in action on missions normally assigned to infantry, engineers do not reorganize to conform to the organization of infantry but enter combat with their normal organization. Minor modifications are made as necessary to provide for the effective employment of the crew-served weapons, for the security of engineer equipment not needed for combat, and for the special problems of command, communication, and ammunition supply incident to combat. A standing operating procedure should be established by all units, including platoons, fixing definitely such modifications as are considered essential.

b. Division into echelons.—(1) When an engineer unit enters combat as a whole it is divided into a forward and rear echelon. The forward echelon comprises those elements that actually engage in combat and also the command, communication, and ammunition supply personnel and equipment necessary to control and supply the combat elements. The rear echelon consists of the personnel and equipment not needed for combat. It includes kitchen and water trucks; trucks carrying engineer supplies and equipment; and special vehicles such as air compressors and tractors. The minimum personnel necessary to maintain the mobility of the rear echelon, provide for its local security, and perform essential administrative functions is assigned.

(2) The actual composition and location of the rear echelon varies with the situation and the size of the unit. Small engineer units operating alone often have it close at hand with only the vehicle drivers for protection. Larger units, such as an engineer battalion participating in the attack or defense of a position, usually have the rear echelon a considerable distance to the rear. The personnel required for its protection varies but should be kept to a minimum. In most situations, the light vehicles are required with the forward echelon for purposes of security, communication, ammunition supply, and the displacement of heavy weapons.

c. *Continuation of engineer operations.*—The engineer operations of the unit normally are suspended when the unit is committed to combat. However, certain types of engineer work, such as the operation of water points and engineer reconnaissance, may have to be continued by personnel of the rear echelon.

■ 37. ORGANIZATION OF COMBAT BATTALION FOR COMBAT.—a. *Combat platoon.*—(1) When organized for combat, the platoon consists of a platoon headquarters; a weapons section to operate the caliber .30 machine guns and the caliber .50 machine gun; and three rifle squads, each including rocket launcher. Combat duties to maintain communication and control are assigned to some members of the platoon headquarters and crews are provided for the heavy weapons, these crews being drawn from the remaining members of platoon headquarters and the three squads of the platoon.

(2) The men provided in the T/O whose sole duties are the operation and control of the platoon heavy weapons are insufficient to provide crews for all of them; therefore, it is necessary to assign men from personnel normally employed on engineer duties. Each combat engineer squad should have a corporal and three men trained as a crew to operate a machine gun. This permits a machine gun to be assigned to any squad for operation and also makes available trained men who can be drawn from the squads to provide crews when the weapons are operated under platoon, company, or battalion control. Each machine-gun crew should be trained to operate either the caliber .30 or the caliber .50 machine gun or any type of direct-fire mission.

(3) The size of the crew provided for a machine gun varies according to circumstances. A machine gun fired from a vehicular mount may be served adequately by two men. In static situations or where only limited movement by hand is required, the efficient operation of either of the machine guns on its ground mount requires four men; and in situations where the weapon must be moved by hand frequently and over considerable distances, a crew of six men normally is required. When the situation requires a large crew, consideration should be given to employing a reduced number of weapons in order not to deplete the rifle squads unduly.

b. Combat company.—The forward echelon of a combat company employed in combat consists of three platoons, the communication and supply personnel necessary to assist the company commander, and often, depending on the method of control and operation of the machine guns, a provisional heavy weapons platoon. The rear echelon usually is commanded by the company motor sergeant.

c. Combat battalion.—For combat, the battalion is organized into a forward and a rear echelon. The major portion of the headquarters and service company is assigned to the rear echelon. The forward echelon of the headquarters and service company consists of the personnel necessary to assist the battalion commander and his staff in the combat duties of command, intelligence, operations, signal communication, and supply. The commander of the headquarters and service company normally remains with the rear echelon of the battalion, and the rear echelon of each of the lettered companies usually are placed under him. When some of the machine guns of the battalion are withdrawn from the companies to operate directly under the control of the battalion commander, it is often necessary to provide for their command and control by personnel of the forward echelon of the headquarters and service company.

■ 38. EMPLOYMENT OF ENGINEERS IN OFFENSIVE COMBAT.—*a. Fire and movement.*—Foot elements attack by a combination of fire and movement. Aimed fire destroys or neutralizes the enemy and protects movement on the battlefield. In engineer units the fire is provided by machine guns and rifles. Rifle elements move by infiltration, by following covered

routes, or by alternate rushes of individuals or small units, in order to establish themselves at closer ranges where more effective fire can be delivered. Enveloping action and positions from which converging and flanking fires can be delivered are sought by preference, even by small units. Rifle elements combine their fires with those of the machine guns, and exploit by alternate fire and movement the resulting neutralization of the enemy. The aim is to close with the enemy and destroy him with the bayonet and other close-range weapons. Units most favored by terrain or supporting fires push forward, while those most exposed support the advancing elements by fire.

b. Technique of fire.—Supporting weapons are kept well forward where the crews can see their targets and can see from the close vicinity of the weapons emplacements the location of the units supported. Fire of all elements is observed fire against point or linear targets. There is not sufficient ammunition and matériel available to permit covering extensive area targets.

c. Security.—Security measures are continuous. Contact is maintained with adjacent units. Detachments are provided to observe and protect exposed flanks and the rear. Antitank weapons are posted to cover approaches favorable for hostile tank attack, their dispositions being coordinated for the entire unit. Antiaircraft and antimechanized warning service is maintained. The principal antiaircraft weapon in offensive action is the rifle. Machine guns not required for essential ground tasks should be mounted for antiaircraft protection of important elements of the unit.

d. Formulation of plans.—The commander prescribes a detailed tactical plan only for that portion of the operation in which he can estimate the hostile resistance. A small unit cannot plan as far ahead as a larger unit because the situation confronting it changes more rapidly. For units smaller than a battalion, it is sufficient to prescribe initially only a simple combination of fire and movement for the capture of ground which can be seen. Simplicity is the keynote of orders and actions. Simple, definite tasks are assigned to the various elements to coordinate their action. Surprise is an essential element of a successful plan of attack. It is gained by concealing the time and place of attack, screening the dis-

positions, employing rapidity of maneuver, and avoiding stereotyped procedures. The plan of attack should provide for a reserve to be held out initially, and used later to exploit weakness discovered in the hostile position or to take over the assault role if the assaulting echelons are stopped. The reserve, when used, is preferably employed for enveloping action.

e. Employment of combat battalion.—(1) *General.*—(a). When engineer units are used as infantry in the attack of a position, normally the smallest unit so employed is the combat battalion. It usually operates under the direct control of the division commander and is assigned a zone of action and an objective by him. Supporting fires beyond the capabilities of the organic weapons of the battalion are normally required. Artillery support is usually furnished and in some cases combat aviation and tanks.

(b) The battalion commander decides on a plan of maneuver, arranges for supporting fire, and coordinates the action of the companies and any supporting weapons under his control by assigning specific missions to them for each phase of the attack. He assigns objectives and zones of action to each company in the assault echelon. The objectives assigned the companies may be parts of the battalion objective or of an intermediate objective selected by the battalion commander. When such an intermediate objective is captured the supporting weapons are brought forward to establish a new base of fire and the battalion is hastily reorganized to attack the next objective in accordance with a new plan prescribed by the battalion commander.

(2) *Employment of antimechanized weapons.*—Antimechanized protection for the battalion is provided primarily by rocket launchers. From time to time during the progress of the attack the battalion commander assigns specific responsibilities to the companies in this connection. He does this by designating the particular directions or approaches for which each company is responsible. It is unusual to concentrate a part or all of the rocket launchers under battalion control for this purpose. The antitank grenade is primarily for the local protection of the units armed with that weapon. The caliber .50 machine gun has a limited

effect against tanks and requires comparatively large crews which in an attack can usually be more effectively employed elsewhere. Because of this, the employment of the caliber .50 machine guns for antimechanized defense during the attack rarely is desirable. When so employed they normally are organized into improvised platoons and sections and handled under battalion control.

(3) *Employment of caliber .30 machine guns.*—In offensive action by units larger than the platoon, effective use of the caliber .30 machine guns normally requires control by company and at times in part by battalion. Usually most of these weapons are controlled directly by the company commanders. Some guns, however, may be withdrawn from the companies and operate directly under the battalion commander or under a temporary commander especially designated by him. Operation of *all* machine guns by the battalion in this manner is rare, since improvising an organization to control so many weapons is impracticable. Six guns is usually the maximum number used in this manner. Centralized control of machine guns in offensive action is most appropriate in open, rolling terrain where conditions are favorable for coordinating and massing supporting fires. In close, broken terrain more decentralization is required, and the guns are operated by companies and even platoons. Frequently, in order to add mobility to the attack, only eight or ten of the caliber .30 machine guns are employed, the crews which would have served the others being used as riflemen.

■ 39. EMPLOYMENT OF ENGINEERS IN TANK HUNTING.—The destruction of hostile tanks which have penetrated our lines is one of the main objectives of tank destroyer units; the principal method of destruction being fire and movement by anti-tank cannon. (See FM 18-5.) However, many occasions will occur when tanks must be attacked by dismounted troops of all arms with the weapons and means available to them. Any type of tank can be destroyed with close combat weapons in the hands of courageous, aggressive men. Small units may be used to attack tanks in bivouac or park. The operation of seeking out and destroying enemy tanks by dismounted troops is called tank hunting.

■ 40. WEAPONS AND METHODS OF TANK HUNTING.—*a.* In addition to rifles, carbines, and machine guns, engineer troops are armed with antitank rifle grenades and rockets. Engineers are equipped, also, with antitank mines, and with means for blowing craters and constructing road blocks. All close combat weapons should be used against a tank as their fire will limit the free use of the tank weapons. All tanks do not have weapons which traverse 360° and those that have require an appreciable time for full traverse. Tank weapons are also limited in depression, leaving a dead space out from the tank as much as 15 feet. The vision of the tank gunners is limited to narrow lanes.

b. Small arms fire at close range is employed to cause the tank crew to close the ports and vision slits, to break the periscope and radio aerial, and to immobilize the turret operating mechanism.

c. Tanks are especially vulnerable to flames. Incendiary (frangible) grenades are employed against upper horizontal surfaces of tanks where the flaming liquid will run through observation slits and ventilation ports or be drawn into the air intake to the engine compartment and set the engine on fire.

d. An antitank mine will effectively stop a tank by breaking its tread. Mines are useful in ambush to disable tanks and to block off hostile supporting tanks.

e. When tanks are slowed down or stopped, smoke may be employed to blind the crew, and rifle and rocket grenades to put the tank out of action. The portable flamethrower will blind the tank and may raise the inside temperature until the crew is forced to evacuate it.

f. When rifle antitank grenades or rockets are not available, a tank must be slowed down or halted by other means, so that foot troops can maneuver around it. In an ambush a string of antitank mines tied together by cord and drawn across in front of an approaching tank, or a mine crater blown just as the tank approaches, will effectively stop it. Explosive charges may be improvised from standard engineer explosives and materials. A "satchel bomb" consists of 12 or more blocks of TNT taped to a board, fitted with a rope or wire loop for attachment to the tank. A "sticky bomb" is

an improvised bomb covered with heavy grease, tar, or other adhesive material thrown or stuck on the tank by hand. Hand-placed charges are usually placed under cover of smoke or a flamethrower.

g. Tank hunters should destroy captured hostile tanks before abandoning them. To do this, prepared charges of high explosive may be detonated on vulnerable points in the following sequence: track and drive sprockets; suspension; turret ring; guns and mounting; engine; and transmission.

■ 41. TANK HUNTING TACTICS.—Tank hunting operations are of two distinct types, each type requiring carefully selected personnel and different methods.

a. *Ambush*.—In all phases of ambush, surprise is essential and concealment a primary consideration. Through reconnaissance, select a suitable site such as a defile between high banks, through woods, or in villages. Devise a plan which will include observation scouts at each end of ambush; fox holes or other effective concealment for the team; effective signals to announce enemy approach; method of stopping enemy reconnaissance element after it has passed the ambush site; method of stopping first tank; means of preventing escape of tanks it is desired to destroy, such as mines across the road or bridges destroyed in rear of them, or other surprise road blocks and antitank obstacles installed by infiltration groups; isolation of tanks by smoke or mines so that mutual support is impossible; designation of team to destroy each tank; and arrangements to withdraw to rallying point.

b. *Raid on tank park or bivouac*.—Prior to a raid on a tank park or bivouac, tank hunters make a reconnaissance to obtain information on tank park size, number of tanks, location of security detachments, and routes of approach and retreat. The success of a raid depends on surprise and silence, and *speed of striking*. Tank hunters strike quickly and silently, cause as much damage as possible, rally outside the tank park, and then return or continue on another mission.

■ 42. EMPLOYMENT OF ENGINEERS IN DEFENSIVE COMBAT.—a. *General dispositions*.—Use of engineers in place of infantry for the defense of a position is an emergency measure, con-

tinued only for short periods. When so used, engineers operate directly under the division commander. Because of differences in strength and armament, a combat engineer battalion employed as infantry in defense of the main line of resistance should not be assigned a frontage greater than two-thirds that assigned to an infantry battalion under similar conditions.

b. Conduct of the defense.—The defensive mission of a unit on the main line of resistance is to stop the enemy by fire in front of the battle position, to repel his assault by close combat if he reaches it, and to eject him by counter-attack if he succeeds in entering it.

(1) Surprise is sought. Every effort is made to keep the enemy in doubt as to the location of the main line of resistance and the principal elements of the defense. Camouflage, varying the defensive dispositions, having alternate positions for small units, and screening action by combat outposts contribute to this end.

(2) The general trace of the main line of resistance and the lateral limits of the battalion area are designated by higher authority. The battalion is disposed to take advantage of observation, fields of fire, concealment and cover, natural obstacles, and routes of communication.

(3) Company defense areas are designated by the battalion commander. Small defended localities, the smallest of which normally is garrisoned by a platoon, are located and organized so as to be mutually supporting throughout the width and depth of the battalion area. In each defended locality and for the battalion as a whole provisions are made for all-around defense.

(4) The small defended localities are located to cover strongly the important approaches to and into the battalion position, to cover gaps in the plan of machine-gun and supporting artillery fires, to protect the supporting weapons in the area, and to provide mutual support.

(5) Elements on the main line of resistance normally fight in place with only those minor changes in position necessary to meet envelopments. Company supports and battalion reserve elements are primarily holding forces, but are employed, when necessary, for local counterattacks.

Possible counterattacks must be foreseen and plans made for them.

(6) The battalion machine guns are disposed according to a coordinated scheme for the battalion as a whole. Alternate positions are necessary.

(7) Regardless of any covering forces or outposts provided by higher authority, local security detachments are posted at short distances to the front and on exposed flanks to give warning of enemy approach.

(8) The battalion depends, in great measure, for its anti-aircraft protection on the concealment and cover afforded by natural features or entrenchments, on the dispersion of its elements, and on the anti-aircraft fires of the automatic weapons of its supports and reserve.

c. Antitank weapons.—The employment of antitank weapons is coordinated by the battalion commander. He does not normally improvise a command organization for them as actual command and control normally are best exercised by the company and platoon commanders. Normally he assigns positions and sectors of fire for such caliber .50 machine guns as may be employed and designates the directions or approaches which each company is responsible for covering with the rocket launchers and anti-tank grenades. In order to make a more effective distribution of antitank weapons to fit the terrain, it may be desirable to take caliber .50 machine guns and rocket launchers from one company and assign them to another. Particular attention is paid to the protection of units on the main line of resistance.

d. Caliber .30 machine guns.—In defense, the coordinated employment of caliber .30 machine guns by the battalion is habitual and the method of control described in *c* above for the antitank weapons is used. The machine guns are sited so as to cover the front, flanks, and depth of the battalion area with mutually supporting fires. Machine guns in the forward part of the area are sited primarily for flanking fires in close support of elements on the main line of resistance. Normally they are sited in pairs. Units smaller than a battalion acting alone in the defense also employ unit control and coordination of machine guns. In smaller units it may be necessary to site guns singly.

SECTION II

SECURITY

■ 43. GENERAL.—*a.* Security embraces all measures taken by a command to protect itself against enemy interference, surprise, and observation. Each commander is responsible for the security of his command. The measures adopted should be appropriate to the threat. As the danger becomes greater, security measures are increased.

b. In all situations security detachments normally are required. Their main mission is to protect against surprise attack and observation by hostile ground and air forces, and to maintain freedom of action for the command by gaining the time and space required to make proper dispositions to meet a threat. Adequate and timely information is the basis of all security measures. Therefore, an adequate warning service is of primary importance. The warning service consists of observers and means of communication to obtain and transmit promptly warning of hostile movements and operations on the ground and in the air. Security detachments deplete the main force and are therefore given only the minimum strength necessary to accomplish their missions. It is desirable that tactical unity be maintained in the security detachments and that they possess mobility at least equal to that of the forces they are expected to oppose. Reconnaissance missions for security detachments are secondary.

■ 44. ON THE MARCH.—*a. General.*—(1) An engineer unit moving on an independent mission provides its own security. Normally, this security is required for the front, flanks, and rear, and against attacks from the air.

(2) When marching alone, an engineer unit usually moves by motor; therefore its security detachments are motorized. These detachments may vary from a small patrol (in the case of a platoon) to company (in the case of a battalion).

(3) Security in front is provided by an *advance guard*. For a battalion, its strength should not exceed a company; for a company, a platoon; and for a platoon, a motor patrol of one or two vehicles. Security from the rear is provided by a *rear guard*. Normally, a rear guard can be weaker than

an advance guard unless there is imminent danger of being overtaken by a force of superior mobility. Flank security for a unit no larger than a battalion generally is sufficiently assured by speed of movement and constant observation to the flanks. Small flank patrols sent out for short distances on specific missions may be useful, although their employment by units smaller than a battalion usually is impracticable. Continuous flank patrolling is possible only when parallel routes exist.

b. Dispositions of security detachments.—(1) An advance guard consisting of a company normally sends forward an *advance party* of a platoon which, in turn, sends forward a small patrol as a *point*. An advance guard consisting of a platoon normally sends out a point only. The advance guard of a platoon moving alone usually is only a point of one or two vehicles. A rear guard is arranged in the reverse order.

(2) Distances between major elements of the unit, such as between the point and the advance party, between the advance party and the support, and between the support and the main body, vary according to the speed of movement and the terrain. At high speeds, distances are increased; at low speeds, they are reduced. These distances vary from about $\frac{1}{2}$ mile in close terrain where visibility is poor, to 1 mile in open terrain. In the case of a rear guard these distances usually are less, due to difficulties of communication. Within the different elements of the command, vehicles are spaced at distances of from 50 to 200 yards in order to provide protection against air attack and to maintain uniform speed.

c. Duties of security detachments.—(1) The advance guard brushes aside minor resistance and in every way facilitates the steady progress of the main body. When the enemy is encountered, prompt and aggressive measures are taken. Advanced elements of the advance guard are reinforced promptly, and normally offensive action is resorted to according to the principles prescribed in section I. As a minimum the advance guard locates the enemy and attempts to fix it in position.

(2) The rear guard gives warning and checks a pursuing enemy. In doing so it seeks to avoid being pinned down,

halting to fight in place only when forced to do so. When necessary to halt to check an enemy, movement is resumed as soon as practicable. Rear elements of the rear guard rarely are reinforced. Elements of the rear guard may halt temporarily in successive positions to resist the hostile advance. Long-range fires are especially effective in rear-guard actions.

(3) Flank security detachments usually are sufficient only to give warning of enemy activity.

d. Dispositions of heavy weapons in security detachments.—Heavy weapons, such as the caliber .30 and caliber .50 machine guns, are not generally placed with small elements closest to an enemy. They are too vulnerable and too valuable to risk their early loss. They are held back with the main body or the main element of the security detachment, in readiness to take position as the situation demands. However, caliber .30 machine guns may be used for supporting fire in the second of two vehicles of a motorized patrol.

e. Antiaircraft security measures.—In addition to a dispersed formation for protection against aircraft as indicated in *b* above, an antiaircraft observation and warning service is maintained. Machine guns are mounted in vehicles for antiaircraft fire if suitable mounts can be provided. Before the movement starts, explicit instructions should be issued regarding the steps to be taken in case of air attack or observation from the air. Measures taken vary with the situation, degrees of visibility, cover afforded by the terrain, and capabilities of the enemy aviation. The column commander may direct that the column clear the center of the road, halt, dismount, and seek cover; or he may direct that the column continue the movement with increased distances. However, if a unit must arrive at its destination at a given time, the commander normally orders the column to continue at increased intervals even if subjected to frequent air attacks.

f. Security for dismounted movements.—Security for engineer units marching on foot is provided for by dismounted advance and rear guards and flank patrols as prescribed in FM 100-5, 7-10, and 7-40.

■ 45. **MOTORIZED PATROLS.**—*a. General*—(1) The motorized patrol is used for reconnaissance and all types of security operations, and particularly as the point of an advance guard.

(2) Motorized patrols are limited in effectiveness by the fact that they are road-bound and therefore easily ambushed and captured or destroyed. While in motion, to obtain security, a motorized patrol should extend in depth along the road. Therefore at least two vehicles, plus any other vehicles required for messengers, are required. Since it must provide protection to both the rear and the front, an engineer platoon moving alone normally has not enough vehicles, weapons, and men to use more than one vehicle in either its advance or rear security patrol without undue dispersion.

b. Comparison of available vehicles.—(1) The $\frac{1}{4}$ -ton reconnaissance truck has a low silhouette, excellent road and cross-country mobility, and a high cruising radius. It is the basic reconnaissance vehicle for engineers.

(2) The $\frac{3}{4}$ -ton truck has many of the characteristics given above for the $\frac{1}{4}$ -ton truck, and is therefore a good vehicle for reconnaissance and security patrols, and for carrying heavy weapons.

(3) The $2\frac{1}{2}$ -ton truck is heavy, has a high silhouette, and has only limited cross-country mobility. When used in a motorized patrol it should operate primarily on roads and should not be used as the leading vehicle.

c. Composition of motorized patrols.—(1) The most suitable vehicles for a patrol or point are the $\frac{1}{4}$ -ton trucks. When a platoon is operating a patrol or point as a part of its security mission for the company, it may be desirable to attach to it a $\frac{1}{4}$ -ton truck from another platoon or from company headquarters. In the absence of a second such vehicle, a $2\frac{1}{2}$ -ton truck may be employed as the supporting vehicle.

(2) The personnel assigned to a patrol or to a point depends on the situation and the vehicles being used. A $\frac{1}{4}$ -ton truck normally carries four men, including the driver. The patrol leader or point commander normally rides in the second vehicle.

(3) Usually only riflemen are used in a patrol or point. One of the riflemen in the second truck should be a grenadier provided with antitank grenades. Each vehicle should carry some antitank mines and it is desirable that they be provided with smoke candles or other smoke-producing means. There should be at least one pair of field glasses on each vehicle.

d. Conduct of a patrol on the march.—(1) When contact with the enemy is improbable, a motorized patrol moves rapidly by bounds from one terrain feature to another. The reconnaissance is visual and hasty, and few halts are made. In open terrain it may be possible to make a continuous advance with the vehicles separated by distances of 1,000 yards or more. The patrol, extended in depth, depends on dispersion and speed for safety. During this type of movement the leader must exercise care to avoid loss of control. Signals between elements of the patrol must be few and simple and easily observed.

(2) When contact with the enemy is probable, the patrol must increase its vigilance. A reconnaissance of each defile and observation point should be made, by dismounted action if necessary. The rate of advance of the patrol becomes slower. Vehicles, when halted, should take advantage of all available cover and concealment. They should never be halted on a crest or in any exposed position, but should pass such features at high speed.

(3) When moving by bounds the first vehicle of the patrol does not advance from cover until a careful visual reconnaissance of the next bound is made. When the bound is completed, the second vehicle upon signal joins the first, which then advances rapidly to the next observation point. The second vehicle covers the movement. Should the terrain prevent such continuous support of the leading vehicle by the vehicle in the rear, the second vehicle regains its supporting position as soon as possible.

(4) Where the terrain is particularly difficult for maintaining continuous mutual observation between the first and second vehicles, the leading vehicle may drop off not more than two men at points where vision is blocked. Such men act as connecting files. The connecting files are picked up

by the following vehicle and are transferred back to their normal place at the end of the bound.

e. Action of patrol under fire.—(1) The action taken by a patrol when fired on depends on its mission. A point normally acts aggressively. It can afford to take such action because it will be reinforced promptly by elements from the rear. A reconnaissance patrol on an independent mission normally avoids combat and seeks to escape to continue on its mission.

(2) If the leading vehicle of a point is fired on, the vehicle commander immediately directs the driver to drive to the nearest cover, to halt, or to take other appropriate action. The fact that contact has been made is signaled back to the second vehicle or to a connecting file if no second vehicle is included. As soon as the vehicle is halted, the occupants dismount, take cover, and reconnoiter in order to locate the enemy and to determine his strength and dispositions. The second vehicle is held under cover initially, and the point commander goes forward to make a personal reconnaissance. Normally, he employs the occupants of the second vehicle to support those of the first and develop the action started by them. If the enemy resistance is not strong, the point destroys or brushes it aside and the advance is resumed. If the enemy is too strong, the point seeks to fix him and thus facilitate the action of elements coming to its support.

(3) If fired on, a patrol whose mission requires it to avoid action moves away at once on its vehicles. If not practicable, the vehicle fired on may have to halt and by fire of its occupants from position nearly facilitate the escape of the second vehicle. In any event a report of the encounter is made immediately to the commander of the force.

(4) When circumstances permit and such action is desirable, a patrol or point encountering the enemy may install antitank mines or other forms of road blocks to prevent the patrol from being overrun.

(5) Smoke may be of value to a patrol to conceal its movements when it is seeking to avoid combat or is forced to withdraw. If smoke cannot be placed on the enemy, the patrol places a smoke screen between itself and the enemy. One method of doing this is as follows: Occupants of the

leading vehicle throws a few smoke grenades to the front as soon as it stops. The truck is then backed up a short distance while a few more smoke grenades are thrown out between it and the enemy. The truck is then turned around and the patrol withdraws.

■ 46. FOR BIVOUACS AND WORK SITES.—In most situations with which engineer units in bivouac or at work are confronted, the types of enemy action to be guarded against are dismounted patrols, motor or mechanized raids, air attacks, and attacks by airborne elements. Unless the situation is exceptional, security against ground interference normally can be provided by small security detachments covering probable avenues of approach. In unusually exposed positions, a thoroughly coordinated system of security elements prepared to resist strongly may be required. Security against air operations is always required and there must be a definite plan of action against such operations. Measures taken against air attack may be either positive or negative. Measures taken against airborne attack always are positive.

■ 47. AGAINST ENEMY GROUND ACTION.—a. Security against enemy ground action is obtained by the use of security detachments operating according to the principles prescribed below for outposts. An outpost is the name given to the entire covering detachment whose duty it is to secure the main body against surprise and observation by enemy ground forces. In principle it is desirable that the outpost be able to make it unnecessary for the main body to act. However, this cannot always be assured without the use of an undue proportion of the command for security duties. The minimum requirement is that the outpost gain the time necessary for the main body to prepare for action. The strength and composition of the outpost vary with the distance, mobility, and aggressiveness of the enemy, the terrain, the time of day, the size of the command to be protected, the degree of resistance the outpost is expected to offer, and any special duties assigned to it. It should be no stronger than reasonable security requires.

b. The outpost of a large command is divided from front to rear into outguards, supports, and a reserve.

(1) *Supports*.—The supports constitute the principal resisting element of the outpost. A support is assigned a sector which is clearly defined by recognizable boundaries within which it establishes an observation and warning service and resists the advance of the enemy. The place or general line along which the support will offer its principal resistance usually is prescribed. By means of outguards, a support establishes an observation and warning service in its sector for its own local security. Patrols, often in light vehicles, are employed to maintain contact with outguards and to reconnoiter areas masked from their view. Patrolling is increased during periods of low visibility.

(2) *Outguards*.—An outguard may vary in strength from a few men to a platoon, depending on its location, the number of sentries it is to furnish, the length of time it must maintain its position, and the strength of the unit sending it out. Its functions are observation of a definite sector, warning, and minor resistance. Outguards normally are established on the principal avenues of approach and preferably at places where observation of their assigned areas is good. Each outguard posts sentries at one or more posts selected by the outguard or higher commander, and may use patrols to maintain contact with its sentries. Concealed locations are chosen for the sentries and for the remainder of the outguard. Men not on duty as sentries rest nearby under cover but remain fully equipped and ready for action at all times. At night the line of outguards may be drawn in closer to the support. The sentries then depend on hearing rather than vision to detect the enemy.

(3) *Reserve*.—The outpost reserve reinforces the supports where necessary or is used as a maneuvering force to counter-attack.

c. (1) The outpost established by an engineer unit rarely is as elaborate as the one described in b (2) above. The outpost of a small engineer unit such as a platoon acting alone often consists only of a few outguards. A platoon rarely uses more than one squad and some of its heavy weapons for security purposes. An engineer company normally uses not more than one platoon, sometimes reinforced by additional weapons and vehicles. A platoon acting as outpost

for a company may establish a support and a line of outguards, or, if it has to cover a very wide sector, may establish outguards only. An engineer battalion normally uses not more than one company for ground security purposes. A company on such duty may establish one or more supports and hold out a reserve, or it may establish only a few supports. Usually, in establishing an outpost, it is best to maintain the tactical integrity of units. Thus, it is better to use an entire company to provide security for a battalion than to use a platoon from each of these companies. Exceptions to this occur when the battalion is required to furnish all-around security at some distance from its position. In such a case it may be desirable to assign each company a sector within which it uses a portion of its force for security purposes.

(2) When the outpost consists only of outguards, the main body acts as the support. If no reserve is provided, the main body serves in that capacity.

(3) Engineer units on outpost duty make a maximum use of obstacles, such as road blocks and hasty mine fields. Usually these are constructed by the outguards and covered by their fire.

(4) The machine guns and antitank weapons with which engineers are armed are especially useful for security purposes. Preferably these weapons are sited in rear of the line of outguards and near the positions of the supports. Machine guns in such positions should enable these weapons to support the outguards and to cover with broad fields of fire the avenues of approach to the main body. If the terrain does not afford such positions, some machine guns may be attached to the outguards and located with them. Wherever the heavy weapons are sited, they must have local protection from riflemen.

(5) Distances at which security detachments operate vary widely, depending on the terrain and the strength of the forces involved. Engineer units in bivouac or at work require protection from direct fires by enemy small-caliber ground and vehicular weapons. In open country this necessitates that security detachments hold the enemy at least 800 yards from the main body. On close terrain this distance may be considerably reduced.

(6) In order that timely warning may be given by elements assigned security missions, they must be provided with adequate means of rapid communication. Full use of radio, vehicles, and visual signals must be made.

(7) All elements of an outpost system must have definite plans for use in case of attack. It is particularly necessary that outguards have precise instructions concerning whether they are to resist in place until destroyed, relieved, or reinforced, or whether they are to withdraw under pressure. If to withdraw under pressure, definite routes of withdrawal must be prescribed to prevent the retiring outguards from masking the fires of elements to the rear. Also, it may be necessary to make special plans for withdrawing weapons posted with outguards, and to provide for their protection both during the movement and after they have achieved new positions.

(8) See figure 1 for dispositions to protect a working party.

■ 48. AGAINST ENEMY AIR ACTION.—*a.* Security against enemy air attack is afforded by warning, concealment, dispersion, and fire. It is important that all men are trained in the identification of aircraft. Air guards are posted to give timely warning of the approach of hostile aircraft. Personnel carriers and elements not needed for engineer work are dispersed and concealed as completely as circumstances permit. During air alarms, if the work is not exceptionally urgent, men take advantage of all available cover and concealment. Engineer units at work sites should site some machine guns for fire against low flying aircraft. The arms of the troops actually at work should be close at hand under guard.

b. Positive action is always taken against attacks by enemy airborne troops. Such troops are especially vulnerable when in the act of landing and immediately thereafter. Heavy weapons are especially suitable for attacking such units before they are organized and for combat concentrated action.

■ 49. AGAINST CHEMICALS.—When an enemy is expected to use chemicals, each commander is responsible for the necessary protective measures against them. For an engineer

unit these measures consist of a warning service, use of individual gas masks, and arrangements for decontamination

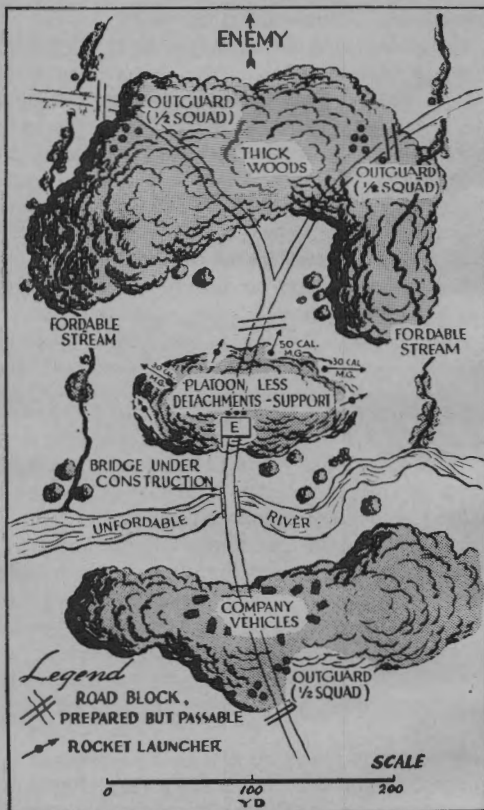


FIGURE 1.—Dispositions of engineer platoon furnishing security for company engaged on construction of a bridge.

equipment and supplies. Gas sentries should be posted upwind to provide warning service, and the men should work with their gas masks close at hand.

SECTION III

DEFENSE OF OBSTACLES AND BARRIERS

■ 50. ROAD BLOCKS.—Engineers may be employed for the defense of road blocks which protect their own bivouacs or working parties, or which are part of the general security plan of a larger force. Generally, road blocks for local security are defended by a squad or part of a squad. Road blocks which are part of the general security plan of larger forces usually are defended by a squad or larger unit.

a. Selection of site.—In selecting a suitable site for a road block it is necessary to consider the following: ease of bypassing the obstacle; materials and labor required, and suitability of terrain for defense and withdrawal of defending garrison. For the technique of preparation of obstacles see FM 5-30.

(1) In some cases, it may be necessary to establish and defend a road block which if undefended could be bypassed with but little delay. In this case the garrison should be of proper size to accomplish the delay desired, but no larger. It is provided with the most rapid means of communication available for reporting contact with the enemy.

(2) Enemy elements whose vehicles are held up by an obstacle will attack by fire and dismounted maneuver to drive off the defenders. The position occupied by the defenders must therefore be suitable for defense against such attack.

(3) Since perfect road-block sites and protective positions are seldom available, great judgment must be used in their selection. Desirable characteristics for the protective positions are:

(a) Concealed locations for principal automatic and anti-vehicular weapons, from which they can cover by fire at close or midrange the obstacle and approaches to their own positions.

(b) Concealed locations for riflemen, from which they can cover the obstacle by fire and protect the heavy weapons against attack by dismounted troops.

(c) Concealed and defiladed positions near weapon emplacements for weapon and personnel vehicles.

(d) Covered routes of communication to the rear for withdrawal or for use of reinforcing elements.

(e) Limited observation and fields of fire for enemy vehicles stopped by road block.

(4) Enemy elements advancing to contact may be expected to operate in such a manner that a second vehicle can support the leading vehicle by fire. An obstacle located just on the near side of a sharp bend limits the effectiveness of the enemy covering vehicles. In special cases obstacles may be established for the primary purpose of destroying enemy vehicles rather than for security. In such cases a site is selected with a view to immobilizing the vehicle in a location where it can be dispatched by antitank weapons or the weapons of close-in tank attack. (See sec. IV.)

b. Disposition of defending garrison.—(1) When a road block is defended only by riflemen, they are disposed in concealed positions from which they can defend themselves against dismounted attack by enemy patrols from any direction. One of the riflemen should be equipped and located to fire antitank weapons at effective ranges on enemy vehicles attempting to pass the block. One or two men are located in forward positions from which they can give warning of enemy approach and can halt friendly vehicles and assist them. Vehicles normally are not provided for such a defending party, but some means (usually radio or visual signaling) must be provided to report rapidly any enemy contact. Figure 2 shows a hasty road block across a road, in heavy woods, defended by a half squad.

(2) For strong defense of a road block, antitank weapons and machine guns are necessary. Antitank weapons prevent armored vehicles from rushing the obstacle and force them to seek cover, thus restricting the employment of their weapons. Defending antitank weapons are primary targets for attacking weapons. Antitank weapons must be concealed so that their location will not be disclosed prematurely, and they should be behind an obstacle to prevent their being overrun by enemy tanks. As the range increases, the weapons are more readily concealed, but the effectiveness of their fire is decreased. An antitank rocket launcher is preferably located about 100 to 200 yards in rear of the obstacle, and similarly a caliber .50 machine gun is located about 200 to 400 yards from the obstacle. Locations on the

flank and off the road being defended are preferable to those on or near the road. All locations selected should be close to concealed and defiladed positions for weapon carriers.

(3) In the defense of a road block, caliber .30 machine guns are used to prevent the removal of the obstacle by dismounted troops. The machine guns are sited so as to cover the obstacle with sustained fire, even though the obstacle is obscured by darkness or by smoke placed by the enemy to cover clearing operations. The gun positions should provide local concealment and good field of fire. Positions 300 to 600 yards away normally are far enough for concealment and

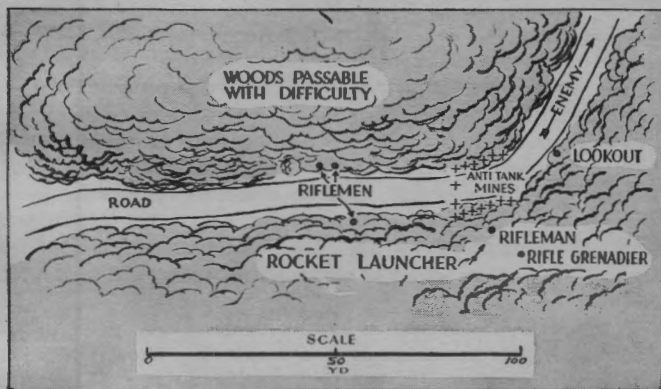


FIGURE 2.—Defense of road block in woods by an outguard of half-squad and attached motorcycles.

near enough for observation. Those on the flanks permit flanking fire against attacking dismounted units. Machine guns preferably are placed sufficiently close to the antitank weapons to permit the use of the same carriers and the same protective riflemen. Weapons are generally not closer together than 50 yards to avoid one being put out of action by fire directed against another.

(4) When antitank weapons and machine guns are available for defending a road block, riflemen are employed primarily for the local defense of the heavier weapons. They are also disposed in small, mutually supporting groups to cover

draws or other avenues of approach which are not covered by the heavier weapons. Some riflemen should be located to cover the obstacle by fire, to defer as long as possible the opening of fire by heavier weapons, and to continue the defense in case the machine guns are withdrawn or put out of action. Other riflemen normally are disposed well forward to give warning of the approach of enemy vehicles.

(5) Alternate positions for all elements of the defense are reconnoitered and are prepared.

(6) Figure 3 shows the dispositions of an engineer squad reinforced by an antitank weapon and a caliber .30 machine gun in the defense of a destroyed bridge.

■ 51. SUCCESSIVE OBSTACLES.—A barrier zone consists of defended obstacles distributed in depth. Engineer units are frequently employed in the defense of barrier zones. The two general methods of defending barriers are described below.

a. Defense in place.—In this method each obstacle is garrisoned by a force which fights in place until relieved or destroyed. Reserves are used to reinforce garrisons most strongly attacked. This method provides a strong defense but can be used only when strong forces are available and where the terrain permits siting of obstacles at places which cannot be bypassed.

b. Defense by delaying at successive positions.—The other method consists in garrisoning initially only those obstacles nearest the enemy. The garrisons of these are withdrawn before being overcome by the enemy and are employed to defend other obstacles to the rear. This method is more economical of means than the first one. The forces employed, however, must be mobile, highly trained, and provided with ample means of rapid communication. This method is the most suitable for delaying the enemy on terrain where the obstacle sites can be bypassed.

(1) The commander of a unit assigned to defend a barrier zone by delaying at successive positions subdivides the zone into sectors and assigns each sector to a major subdivision of his command. Normally, a company is the smallest unit assigned a sector. (See fig. 4.) Sectors extend entirely across the barrier zone, and boundaries between sectors are selected so as to include each main route of approach in a

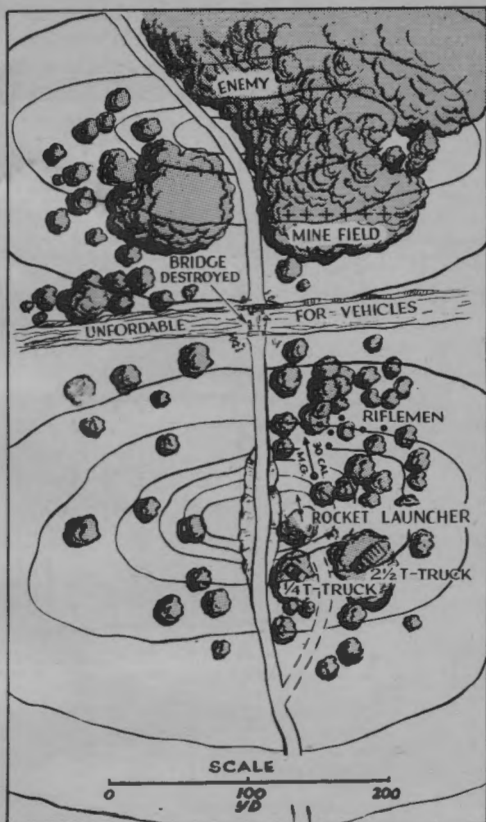


FIGURE 3.—Defense of site of destroyed bridge.

single sector. Sector commanders may subdivide their sectors into smaller subdivisions.

(2) Each sector commander reconnoiters his sector and selects suitable sites for road blocks in depth on all routes. He then assigns to appropriate subdivisions of his command obstacles to be created and defended. Each subdivision is assigned initially at least three obstacles in depth of each route.

(3) A subdivision commander then organizes his unit into detachments, each of which is armed and equipped to construct and defend an obstacle and to withdraw by vehicle when forced to do so by the enemy. These detachments are

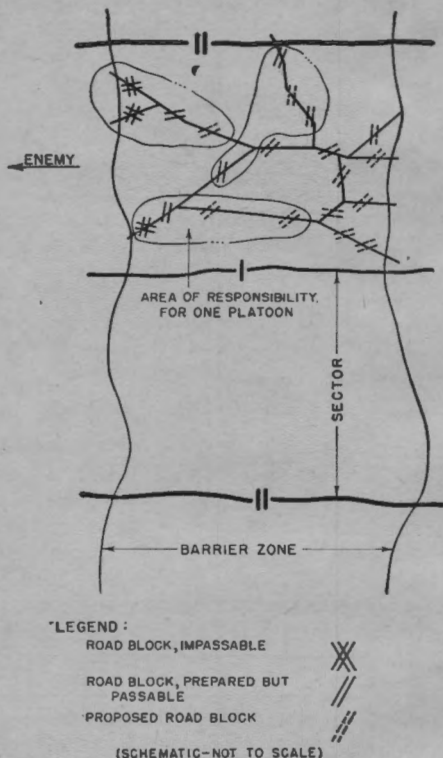


FIGURE 4.—Initial dispositions of an engineer company for defense of a sector of a barrier zone by delaying at successive obstacles.

assigned to construct and defend obstacles initially at sites where the enemy will first make contact. When a detachment defending one of the forward obstacles is forced to withdraw, it withdraws past and is covered by another de-

tachment which is already in position to defend the next obstacle to the rear. It then prepares another obstacle, defends it, and from it covers the withdrawal of the detachment in front.

(4) In the defense of road blocks in depth, full advantage should be taken of opportunities for ruses and deceptions; these will instill in the enemy a feeling of fear and uncertainty and, by forcing him to dismount and reconnoiter many points not defended, delay him. Such deception is accomplished principally by employing dummies, screens, and undefended mine fields at numerous points between the positions selected for defense. For details of methods employed, see FM 5-30.

(5) The commander of each sector must be promptly informed of the location of obstacles installed and the progress of any attack. He takes all necessary steps to insure that no gaps develop in his part of the barrier. He reports promptly to his commander details of any enemy attacks. Figure 5 shows the employment of an engineer platoon in the defense of successive obstacles.

■ 52. DEMOLITION SITES.—An engineer unit may be assigned the defense of a bridge and told to demolish it only to prevent it from falling into the hands of the enemy. In such a case the bridge is prepared for demolition ahead of time, and the charges are placed carefully to insure destruction in a single explosion. To guard against misfires, alternate methods of firing are provided. Personnel charged with firing the charges are afforded protection by fox holes or other shelters and by riflemen detailed specifically for that purpose. Sufficient force must be kept near the bridge to guard against its capture by parachute troops. The charge is fired only on orders from the commander of the defending unit or his successor. The defensive position selected by the defending force is generally at or near the bridge; this position is often on the far side of the river, but may be on the near side if firing positions are available from which the charges can be protected against removal by the enemy. An outpost system on both sides of the river provides for the security of the defending force and of the bridge. In favorable terrain,

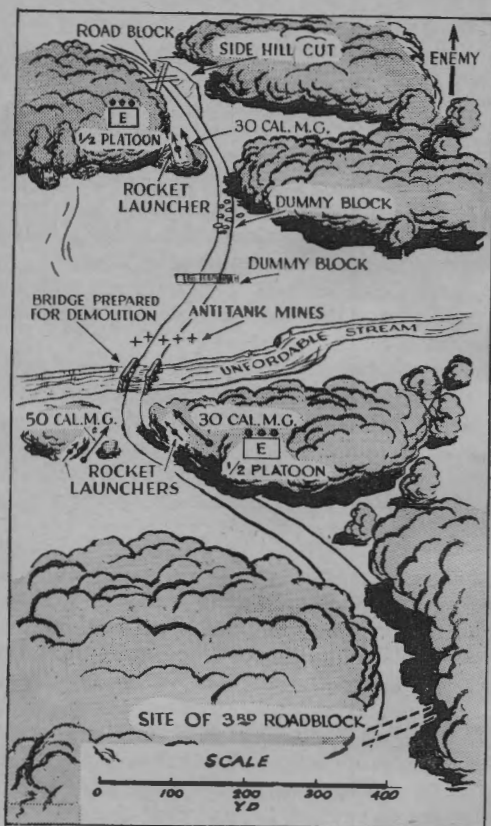


FIGURE 5.—Engineer platoon defending series of obstacles.

most of the defending force may be employed initially as outposts and for defending successive road blocks.

SECTION IV

PASSAGE OF ARTIFICIAL OBSTACLES

■ 53. GENERAL.—*a.* This section deals with the passage of artificial obstacles. Common types are barbed-wire entangle-

ments; mine fields; prefabricated obstacles such as tetrahedrons and concrete blocks; steel, wood, and concrete post obstacles; timber obstacles such as abatis and cribs; and antitank ditches. Detailed description of techniques of passing obstacles is found in FM 5-30.

b. In the passage of obstacles, the first step is usually to neutralize the defending fires. Generally other arms do this and then engineers or other specially trained troops are employed to clear the obstacle. If resistance is overcome in advance, the engineer task is greatly simplified. However, in an attempt to gain surprise, preparations for the breach may be made in secrecy or under cover of darkness, with or without supporting action. In many cases engineer work must proceed simultaneously with the combat action of other arms. This necessitates maximum coordination which generally requires a rehearsal by all troops taking part.

■ 54. METHODS OF CLEARING OBSTACLES.—The methods of forcing a passage through an obstacle may be grouped under five main headings: destruction by hand-placed explosive charge, hand removal, destruction by artillery fire or aerial bombardment, surmounting or bridging, and destruction by fire of tank weapons.

a. *Destruction by hand-placed charge.*—Breaching an obstacle with hand-placed charges is an efficient method. Obstacles of concrete, wood, or steel are readily destroyed by using explosives in accordance with standard demolition practices. Hand-placed charges are also effective for clearing gaps in mine fields. After the individual mines are located by mine detectors or by probing and hand searching, small charges are placed on each mine and connected by means of primacord to a main line of primacord running along the center line of the proposed gap. All mines in the gap are then destroyed when the main line of primacord is detonated. The firing of charges that have been placed in secrecy or under cover of darkness should be timed so that the breaches in the obstacles will be used immediately. Bangalore torpedoes are used extensively in breaching barbed-wire entanglements, and may also be used for clearing gaps through mine fields.

b. Hand removal.—The clearing of gaps in mine fields for the passage of tanks can be accomplished by hand removal. In this method the mines are first located by probing or by mine detector. If tanks are to lead the attack this is done secretly the night before. If the infantry leads, as is normal, it is done as soon as an infantry bridgehead is established. After being located and marked by trained specialists, the mines are disarmed and removed. Experienced men carefully uncover the mines, ordinarily by digging with their hands, determine the type of mine and nature of any auxiliary firing device, disarm the mines, and remove them. Antitank ditches can be quickly and effectively prepared for passage by pulling down the vertical banks with picks and shovels. The hand removal of well-constructed concrete, wood, or steel obstacles usually requires too much time and cannot be done secretly.

c. Destruction by artillery fire or aerial bombardment.—Reliable results in breaching obstacles cannot be expected from artillery bombardment. Some obstacles may be damaged and some destroyed by direct fire at short ranges. If indirect fire or bombs are used, the expenditure of ammunition will be large in proportion to results obtained. However, artillery preparatory fires often will discover the location of mine fields by exploding some of the mines.

d. Surmounting or bridging.—Surmounting or bridging is impracticable for crossing enemy mine fields, but is effective in passing certain forms of tank or personnel obstacles, particularly ditches and craters. Wire netting or mats may be used for surmounting barbed-wire entanglements. Heavy crater charges placed in roads by the enemy may be bridged unless it is quicker to remove the charge, or to explode it and then repair the road.

e. Bombardment by tank weapons.—Obstacles which are susceptible to breaching by light artillery fire may be attacked directly by the fire of medium tanks.

f. Method of breaching.—The decision as to the method of breaching the obstacle is made by the commander of the attacking force after consultation with his engineer. The decision is based upon the mission; type of obstacle; time required; requirements of secrecy; type and strength of defending fires; and matériel and support available.

■ 55. RECONNAISSANCE AND LOCATION OF OBSTACLES.—*a. Information of enemy.*—The gathering of enemy information of an engineering character is a continuous process with engineer troops. It is not connected with any one operation. Engineer troops must be intimately familiar with enemy mine matériel, mine-laying technique, and with all enemy obstacles.

b. Preliminary reconnaissance.—In a fast-moving offensive, obstacles must be reconnoitered as soon as encountered. The first indication of a mine field is often the exploding of a mine by a reconnaissance vehicle. The reconnaissance of a deliberately organized position requires a careful map study and general survey of the ground to determine the probable location of mine fields and other obstacles. Air and ground photographs should be carefully examined. Enemy movements should be watched and particular attention paid to his selection of paths and tracks. Seemingly unnecessary twists and turns may indicate the location of a mine field or of a passage through one. Antitank ditches and steel and concrete obstacles usually can be identified on aerial photographs.

c. Ground reconnaissance.—The exact location of an obstacle and its extent and nature must be determined by ground reconnaissance. Ground reconnaissance prior to the attack usually is possible only for those obstacles in front and on the flanks of the enemy main battle position. It must be done with the greatest secrecy. The boundaries of mine fields and the locations of individual mines are determined as accurately as conditions permit. Information is obtained as to the type of mines; the presence of gaps in the field and the method used, if any, for marking these gaps; possible detours and approaches; and the location of defending weapons and gassed areas. The reconnaissance parties seek to determine the portions of the obstacles which are best adapted for clearing operations, either because of weakness in the obstacle itself or because of weak spots in the enemy plan of fire.

d. Organization of reconnaissance parties.—Reconnaissance of enemy obstacles requires careful organization and skillful execution. Normally the reconnaissance is executed by the troops who are to breach the obstacle. Parties are given definite areas of responsibility and are thoroughly instructed

in their duties. The officer in charge studies all available information on enemy mine material and technique, and sees that this information is transmitted to all personnel. The size and composition of each reconnaissance party is determined by the situation. Since detection of the reconnaissance parties may disclose the commander's intentions, secrecy is of primary importance. The parties are made as small as consistent with the accomplishment of their mission.

e. Recording mine-field pattern.—If detailed information regarding type and location of mines in an enemy mine field is desired, a specially organized reconnaissance party is sent out at night. The party locates and marks clearly all anti-tank and antipersonnel mines found in the proposed gap, and removes slack trip wires. The mines are usually located by probing and hand searching. A length of white cord or tape is stretched along the approximate center line of the gap through the mine field. A system of knots and short pieces of tape perpendicular to the center (tape) are used to mark the character and location of each mine. Upon completion, the tape is taken back to a rear area, laid out, and from it the pattern and locations of the mines determined and an accurate sketch made. This procedure of bringing in a physical pattern of the mines in the gap is designed to overcome the difficulty of determining distances in a kneeling or prone position and of making notes in darkness. Details of this procedure are covered in FM 5-30.

f. Reconnaissance during attack.—During the attack ground reconnaissance for obstacles must be continuous. This is necessary so that obstacles already captured may be cleared for other troops without delay and so that obstacles encountered within the enemy position may be breached promptly.

■ 56. USE OF SMOKE.—Smoke should be used to mask operations and reduce casualties when obstacles must be removed under conditions which prevent surprise. The smoke should be laid either as a screen between the obstacles and the enemy lines or on the enemy front line and observation posts. Mortars and artillery normally are used to place smoke on the enemy, but under some conditions of wind and weather it may be possible to lay and maintain an effective smoke

screen by using pots and grenades. When smoke is employed it should be used over large areas, as small concentrations only draw fire.

■ 57. EMPLOYMENT OF ENGINEERS.—*a. Assignment.*—Engineer units clearing obstacles may operate under engineer control or may be attached to another unit. Where the operations are for the purpose of facilitating the movement of a single unit, such as an infantry regiment or tank battalion, the necessary engineers are attached to that unit and revert to their own command after the tasks for which they were attached are accomplished. However, the commander of the engineer unit from which the smaller units are detached should supervise carefully to insure that the detached engineer elements carry with them the supplies needed.

b. Organization of clearing parties.—(1) The strength, organization, equipment, and means of transportation for each clearing party must be carefully planned considering its mission and the known characteristics of the obstacles to be cleared. Parties may be organized to clear obstacles in front of the enemy main line of resistance at the beginning of the attack; to accompany tanks or front-line infantry units; to clear obstacles encountered within the enemy position after the attack begins; or to mark and remove obstacles already passed by the leading elements. Clearing parties must have the same mobility as the units they accompany. Clearing parties accompanying infantry generally move on foot and should not carry such heavy loads of engineer equipment and supplies that they will not be able to keep up. Engineers accompanying tanks normally are transported in trucks or tanks. Supplies carried must be carefully planned so as to provide all essentials and eliminate nonessentials.

(2) Clearing parties normally are organized into task groups. When the obstacle to be cleared is formidable and complete information about it is available, the organization for clearing the obstacle can be highly specialized and the men forming each specific task group can be instructed in detail and rehearsed in the performance of precise duties. However, to cope with obstacles which will be encountered after the attack begins and concerning which only incomplete information will be available, a flexible organization

must be adopted. Groups to perform each of the following functions may be included in a party; clearing antipersonnel mines, breaching the obstacle, marking the gap, providing local security, laying smoke locally for protection of clearing operations, and providing replacement or reinforcement of other groups.

c. Conduct of clearing operations.—Passages cleared through obstacles must be located at exactly the places ordered by the higher commander. This is the responsibility of the commander of the clearing party. A marking detail generally is organized for this, utilizing issue marking equipment or improvisations. A breaching detail may be preceded by a group to clear away antipersonnel mines. A breaching detail may employ hand-placed charges, hand removal, bridging or surmounting for the passage of primary obstacles. The mines are removed by hand or destroyed in place by explosive charges or mechanical means. When the obstacle or obstacles have been breached, the marking details mark the boundaries of the gaps created and the routes between gaps in successive obstacles. When enemy interference with the clearing operations is likely, the support group provides local security. In such a case, the clearing party may lay down a smoke screen, but normally smoke required is laid by other troops. Reserves of men and materials are provided to replace losses.

■ 58. **REAR-AREA OBSTACLES.**—Engineers accompanying troops that have broken through, enveloped, or been dropped in an enemy position are used to overcome rear-area obstacles. Most of these obstacles will not be so thoroughly covered by enemy fire as front line obstacles, and the engineers will be able to clear passages more rapidly. In order to clear obstacles with the least delay, demolitions are extensively used.

SECTION V

ASSAULT OF PERMANENT FORTIFICATIONS

■ 59. **GENERAL.**—*a.* Assault of permanent fortifications is normally an infantry mission, and an infantry platoon is the basic tactical unit used. Each infantry platoon is prepared to furnish one assault detachment, with replacements, and is given basic training with that end in view. Engineer

units should train in the tactics and technique of assault of permanent fortifications in order to assist in development of technique and be prepared to participate in such attacks.

b. *Permanent fortifications* include fortified weapon emplacements, protected shelters, and entrenchments and obstacles. A *fort* is a strongly organized group of emplacements, shelters, and other underground installations connected by protected passages. A *fortified locality* is a single strongly organized defensive work or series of works. A continuous belt of defensive works disposed primarily to protect against attacks from a certain direction is a *fortified line*. A *fortified zone* consists of a series of fortified localities disposed at great depth, or of two or more fortified lines separated by such a distance that artillery cannot fire on each line successively without displacing forward. A *fortified position* is a defensive area containing numerous defensive works of steel, concrete, or other permanent material.

■ 60. PHASES.—The attack of a fortified position may be divided into four phases as follows:

- a. Reducing hostile outpost system and developing main position.
- b. Breaking through position at most favorable point.
- c. Widening gap.
- d. Exploitation.

■ 61. TRAINING.—Troops which are to participate in the attack of a fortified position should receive special advance training. This should include technical training for men who handle special equipment or weapons. When practicable, practice operations by assault echelons and close supporting artillery are carried out on facsimiles of fortified areas to be attacked. Aerial photographs and results of intelligence studies of enemy fortifications are made available to commanders of all echelons. For the breaching of major fortified positions, special units should be organized and trained for that purpose only.

■ 62. WEAPONS.—a. Local air superiority must be obtained early and maintained throughout the operation. Bombardment aircraft is used to supplement the artillery preparation, disrupt movement of enemy reserves, break up coun-

terattacks, and support the ground forces in the exploitation of a gap.

b. Indirect fire by artillery accomplishes considerable destruction in the fortified area, neutralizes enemy artillery, prepares the position to be assaulted, and covers the approach of direct-fire weapons and assault troops.

c. The direct fire of weapons employed as assault guns at close ranges is extremely effective against fortified works and is the best method of neutralization or destruction. Even when the assault fire cannot destroy the emplacement, if directed against embrasures it can neutralize the guns firing from them. For these missions, a highly mobile, quick-firing gun of high muzzle velocity, capable of direct-laying methods, is used.

d. The *rocket, AT, 2.36 inches, M6*, is suitable for destructive or neutralizing fire against embrasure doors. The optimum range is about 300 yards against large targets. The rocket will penetrate 3.5 inches of armor plate or 8 inches of concrete at any range. The launcher weighs approximately 15 pounds, the projectile about $3\frac{1}{2}$ pounds. Two men are required to operate the launcher.

e. The *grenade, HE AT, M9A1*, weighs about $1\frac{1}{3}$ pounds and has a penetrating effect on steel somewhat less than that of the AT rocket. The projectile is launched from the rifle by use of special equipment. It has a highly curved trajectory, and an effective range of about 40 to 60 yards.

f. The *portable flamethrower*, carried on the back of a man, is used to furnish protection to the demolition man during the interval of time after direct fire against an embrasure has ceased, and prior to placing the breaching charge. The smoke and flame fill the embrasure, blinding vision slits and pouring into any apertures. The operator can employ the flamethrower at an angle from which he cannot be hit from the embrasure. The flamethrower may also be used as a casualty-producing weapon, filling a pillbox with flame through an embrasure or a hole breached by gunfire or demolition.

■ 63. USE OF HAND-PLACED CHARGES.—Hand-placed explosive charges will breach any fortifications. The charges are placed in embrasures, against doors, or other weak points. They are normally used in the following forms:

a. A *satchel charge* consists of a number of blocks of explosive tied together, capped, fuzed, and ready to be fired. Minimum weight of charge should be about 15 pounds.

b. A *pole charge* is similar to a satchel charge, except that it is mounted on the end of a pole. It may be placed into positions which are out of hand reach.

c. The *beehive-shaped charge* is designed to concentrate its explosive force in one direction. They can be made large enough to blow a hole through any but the most massive structures.

■ 64. ASSAULT UNITS.—a. *Infantry battalion*.—The infantry battalion used in the assault is provided with weapons adapted for use against permanent fortifications. These include flamethrowers, smoke grenades, demolition equipment, and rocket launchers. Direct-fire artillery weapons, usually from tank destroyer units, are normally attached. Engineers may be used for breaching obstacles and other engineer tasks. Chemical troops may be included. Extra communication facilities and personnel are usually provided, including telephones, Very pistols, ground signal projectors, and portable radios. The battalion has direct communication and command liaison with supporting artillery and bombardment aviation. A company of an assault battalion may reorganize one or more platoons for assault missions to best utilize the special weapons issued. A platoon may be formed into an assault detachment and an infantry support.

b. *Assault detachment*.—(1) For an assault against a position composed mainly of concrete or steel weapon emplacements, a suitable assault detachment would be approximately as follows:

Personnel	Number of men
Detachment leader.....	1
Assistant leader.....	1
Rocket (or grenade) party.....	4
Flame party.....	2
Demolitions party.....	3
Support and wire-cutting party.....	5
Total	16

(2) Arms and equipment may include the following:

- Flamethrowers
- Demolition charges
- Rocket launchers (or grenade dischargers)
- Bangalore torpedoes
- Wire cutters
- Wire-cutting pliers
- Hand grenades (fragmentation and offensive)
- Signal projectors
- Carbines
- Submachine guns
- Automatic pistols
- Smoke grenades

■ 65. PRELIMINARY OPERATIONS.—A heavy artillery preparation is laid down, supplemented by bombardment aviation. Flat-trajectory artillery and troops participating in the assault move forward into position. The fire of flat-trajectory artillery is directed against the embrasures of certain fortifications. Preparation fires are lifted, either on time schedule or on prearranged signal, to targets in rear and to the flanks of the sector to be assaulted. Smoke may be used to screen enemy observation. Protected by supporting fires, engineers under division control move forward and open lanes through undestroyed wire, remove obstacles, blow mine fields, and prepare crossings over other principal obstacles. These engineers make gaps in major obstacles for the passage, first of personnel on foot and, as soon thereafter as possible, of vehicles attached to infantry assault battalions. Chemical troops attached to infantry assault battalions open lanes through any contaminated areas which cannot be avoided. The assault detachments advance as far as possible before the fires lift.

■ 66. THE ASSAULT.—a. When fire is lifted, the assault echelon of the battalion, including assault detachments and supporting infantry elements, attacks according to prearranged plan. The advance must be made aggressively with every precaution being taken for individual concealment. Supporting infantry elements seize unfortified defense areas and place small-arms and mortar fires upon other more

distant localities from which hostile fire may cause casualties in the assault detachments. Flat-trajectory guns within the assault infantry battalions neutralize weapon emplacements which could fire upon the assault echelon. Smoke may be used, but only in places where it cannot interfere with fires of close support artillery.

b. Protected by supporting fires, including fire against embrasures and loopholes by high muzzle-velocity, flat-trajectory weapons, and taking advantage of all cover available, assault detachments advance and destroy emplacements which have not previously been destroyed by artillery fire. The assault detachment has but one mission, to destroy a fortified emplacement. Methods used are as follows:

(1) The detachment advances under the fires supporting it and through gaps in major obstacles breached by engineers. If further obstacles are encountered they are removed by the infantry support and the wire-cutting party of the assault detachment. The wire-cutting party also covers the advance of other personnel by fire.

(2) The best way to advance upon an emplacement is in space not covered by fire from the embrasures. If this is impossible, the defenders may be forced away from their weapons or forced to close the ports, by fire directed against the embrasures. At closer range, temporary neutralization may be accomplished by discharging a flamethrower or throwing grenades into the embrasure. In some cases neutralization by fire either from division artillery or from the artillery with the infantry assault battalion is sufficient.

(3) A temporarily neutralized emplacement is breached and personnel inside destroyed by throwing explosive charges into openings, or by firing antitank rockets or antitank rifle grenades through steel doors or ports, followed by hand grenades if necessary. Fortified works, whether neutralized or not, can be destroyed by explosive charges, placed by hand by personnel who have approached in the dead space.

■ 67. CONTINUATION OF ATTACK.—a. After the assault of an emplacement, time is taken only for essential reorganization within the platoon. Security elements are pushed forward rapidly from the assault party and support elements, and the advance is continued. Battalion reserves and local sup-

ports are moved up. Any halt is dangerous, because of the speed with which a local hostile counterattack can be organized and launched, supported by weapons which are already in position and highly coordinated.

Small isolated resistances which have been passed over are reduced by special mopping-up detachments from supporting and reserves. Special attention is given to underground works which have not been completely destroyed and may still be occupied.

b. As the attack progresses, fire of assault weapons must be shifted from one target to another without impeding the advance of assault detachments. This requires that the plan for control of such fire be carefully made. Artillery is displaced forward promptly. Liaison between indirect-fire artillery, the attacking battalions, and supporting aviation is maintained by all possible means of signal communication. As the breach of the enemy lines is deepened, additional assault detachments from battalions and later regimental reserves are sent into the gap to attack the flanking works in each direction and widen the base of the penetration. Troops in rear are pushed rapidly through the gap created. Engineers under division control are pushed forward to restore communication close behind the leading battalions. Operations are continued until the entire front selected for the break-through is reduced. As the attack progresses, the flanks of the penetration are strongly organized for defense against hostile counterattacks.

CHAPTER 5

RIVER-CROSSING OPERATIONS

	Paragraphs
SECTION I. Tactical procedure.....	68-78
II. River-crossing means.....	79-89
III. Engineer plan for operations.....	90-100

SECTION I

TACTICAL PROCEDURE

■ 68. GENERAL.—a. The immediate object of the attack of a river line is to establish one or more bridgeheads to protect the crossing of the remainder of the command. A division usually crosses as part of a larger force, with one of the following missions: to force the main crossing, to make a secondary crossing, or to feint. (See fig. 6.)

b. One or the other of two general situations normally confronts a division planning to cross a stream over which the enemy has destroyed the bridges. In the first, the opposite bank of the stream is strongly held by the enemy and a *deliberate river crossing* is necessary. In this situation the crossing must be made on a broad front and powerful fire support must be organized. In the second, the opposite bank is lightly held by the enemy. When this is the case, the division should cross a portion of its strength immediately, to establish and hold a bridgehead to cover the crossing of the remainder of the division. Such an operation is called a *hasty river crossing*.

c. Reconnaissance, planning, and assembly of necessary forces take place during the preparatory phase of the operation. Thereafter, the crossing of each element is conducted in four steps: movement forward from initial assembly areas to final assembly areas; movement from final assembly areas to the crossing points; crossing; and attack on far bank to seize successive objectives.

d. The force landed on the far bank usually has three successive objectives (see fig. 7):

(1) *First*.—A position the capture of which will eliminate effective direct small-arms fire upon the crossing front.

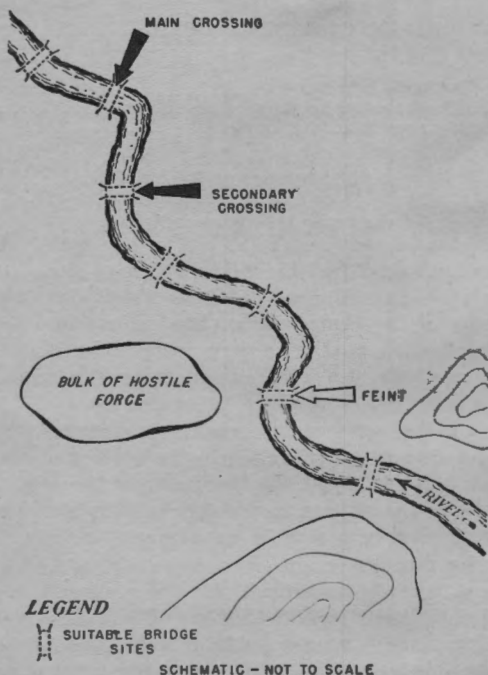


FIGURE 6.—Typical plan for attack of a river line.

(2) *Second*.—A position the capture of which will protect the selected ponton-bridge site from ground-observed artillery fire and which can be supported by light artillery on near side of the river.

(3) *Third*.—A position the capture of which will protect the bridge site from all artillery fire and will provide proper maneuver space on the enemy side of the river.

■ 69. SPECIAL CASES.—*a. Hasty river crossing.*—Advanced elements are crossed by such equipage as is readily available or can be improvised. The crossing must be boldly executed. It is worth taking risks to prevent the enemy organizing strong defenses. Plans should provide for the arrival of leading elements on a broad front to take advantage of any weak spots in the enemy position. In such an operation, time is of greatest importance and detailed reconnaissance and planning must be dispensed with. Engineers are usually attached to larger units of the division in such crossings.

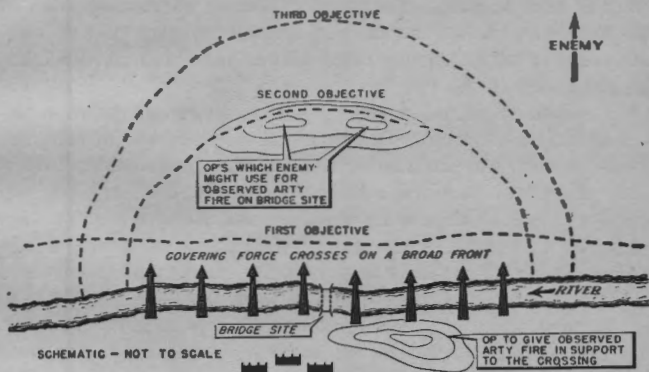


FIGURE 7.—Objectives.

Engineers assist in utilizing commandeered and expedient crossing means, and construct rafts for the crossing of anti-tank guns and combat vehicles.

b. Airborne troops.—Airborne troops may be used in the attack of a river line. When possible, they seize bridges by surprise and obviate the necessity for a river crossing. In many situations, they are dropped or landed beyond the river at about the time of the main crossing with missions of disrupting communication and hindering the movement of hostile reserves. The crossing is planned so as to effect a junction with the airborne troops as soon as possible.

c. Armored, motorized, and cavalry divisions.—Information on special features applicable to river crossings by these

units is found in chapter 11. Deliberate crossings by such units are rare, but, when necessary, are conducted generally according to the methods given in this chapter.

■ 70. RECONNAISSANCE.—*a.* Reconnaissance of river lines in the zone of advance is begun early by general staff, infantry, and engineer officers. Personal aerial reconnaissance should be performed if possible. Aerial photographs showing the nature of the river, favorable routes of approach, and the bridge destruction effected by the enemy enable higher headquarters to make an early estimate of the possibilities of crossing and of means required. Ground reconnaissance of the river line should be pushed, but ordinarily can be executed only after hostile covering forces have been driven from the near side of the river.

b. Ground reconnaissance by patrols provides detailed information and furnishes the basis for the selection of crossing points and for the execution of necessary preparatory measures. It should include reconnaissance of the far shore in depth to determine enemy dispositions, enemy observation points, the presence and nature of natural or artificial obstacles which might interfere with the landing of troops and material, and the location of roads and trails.

c. Reconnaissance must be conducted with great secrecy. To this end, reconnaissance parties are limited to those strictly necessary and are kept to a minimum size. For deception, some parties may be sent to points where crossings are not to be made. Parties reconnoitering the shore in daylight must remain concealed.

d. Engineer reconnaissance should be in sufficient detail to prepare an estimate of the terrain, to select the most promising crossing points and determine the means required at each point, to select final assembly areas and available routes to the stream, and to prepare other features of the engineer plan.

■ 71. WIDTH OF CROSSING FRONT.—*a.* The crossing front is usually prescribed by higher authority by means of boundary lines or frontages or by designating limiting points on the river.

b. The crossing is habitually made on a broad front. For protection during the crossing and ease of deployment after

landing, intervals between assault boats during the crossing should be not less than 20 yards.

c. The following frontages upon which infantry units operate may be employed as guides in river-crossing operations:

<i>Unit</i>	<i>Frontages in yards</i>
Platoon -----	100 to 300
Company -----	300 to 1,200
Battalion -----	600 to 2,400

■ 72. FORMATION.—Tactical unity is maintained as far as possible in assigning personnel to boats and other crossing means. If the necessary means are available, one satisfactory method of distributing them is as follows:

In assault boats: Leading wave: Attacking rifle companies (less transport) and artillery forward observers.

Second wave: Heavy weapons company (less transport), first echelon of the battalion command post, and artillery and attached (or supporting) cannon platoon liaison details.

On footbridge (or rafts): Battalion reserve, battalion headquarters company (less detachments), and medical section (less detachments).
Antitank platoon.

On rafts (or ponton bridge): Artillery and all motor transport.

■ 73. ENGINEER TROOPS AND MATÉRIEL.—a. Amounts and kinds of engineer troops and matériel must be estimated well in advance. These estimates should be available early in the planning stage so that detailed reconnaissance can be made and equipment prepared and properly disposed. Engineer troops with the necessary crossing equipment are usually attached to the leading infantry regiments making the crossing on each front. In addition, engineer troops and matériel must be provided to erect bridges and assemble rafts for the benefit of the command as a whole, to reinforce the crossing at decisive points, to replace losses, and to do other engineer work, such as maintenance, construction of approach

roads, and extension of the road net. When the crossing of the division is strongly opposed, the strength of the division engineer battalion is inadequate to carry out all the engineer duties and additional engineer troops and special equipment must be secured from corps and army.

b. The unit engineer is charged with all technical preparatory measures for the crossing, for the distribution of engineer troops and matériel, the construction and guarding of bridges, and regulation of traffic thereon. The division engineer with his staff must make plans for the control of engineer elements attached to the division, and must insure that engineer reconnaissance is sufficient to obtain all information necessary. He must keep abreast of the situation at all times, and must be prepared to make appropriate recommendations to the division commander whenever changes in the engineer situation affect the tactical plan.

■ 74. ADVANCE.—a. *Initial assembly areas.*—In preparation for the crossing, most of the troops concerned are placed secretly in concealed initial assembly areas. These are usually out of hostile artillery range but within easy night-marching distance of their final assembly areas. Only covering forces and the necessary reconnaissance parties are permitted to approach the river. The ponton equipage, because of its vulnerability, difficulty of concealment, and importance of its location as an indication of intentions, normally is held well back in rear areas and is brought forward to the bridge site without intermediate bivouacs. Whenever possible, troops are assigned to assault boats before leaving initial assembly areas.

b. *Final assembly areas.*—The final assembly areas are reconnoitered by parties from the engineer units which will assist the infantry units. If possible without loss of secrecy, the members of each engineer boat crew reconnoiter the route over which their boat will be carried and the point on the river from which the boat will be launched. An ideal area would be—

(1) Accessible to trucks (or carrying parties) bringing up the assault boats.

(2) Concealed from hostile ground and aerial observation.

(3) Connected with numerous clearly defined foot routes to the river.

(4) Close to the actual crossing front. It should be selected to permit placing the assault boats within 100 to 200 yards of the river edge, unless lack of cover prevents, so as to reduce hand-carrying by infantry to a minimum.

(5) Parallel to the river to allow both for crossing on a wide front and for proceeding directly and without delay to the embarkation points.

(6) In defilade from fire of hostile flat-trajectory weapons.

c. Movement forward.—Figure 8 indicates schematically the sequence of operations in providing security, carrying out combined infantry-engineer reconnaissance, and scheduling movements forward from initial assembly areas. It also indicates the coordination required between movement of engineer means and movements of the infantry and artillery.

■ 75. CROSSING BY ASSAULT BOATS.—*a. Procedure.*—Under cover of darkness, all troops go into their selected positions. The assault boats are brought to the final assembly areas by truck when the terrain, the road net, and the requirements of secrecy permit. Engineer troops unload the boats, carry them to the boat-group assembly areas, and distribute them along the foot routes to the river so that they may be readily picked up by the infantry carrying parties. They place the boats from 100 to 200 yards of the river edge unless lack of cover requires a greater distance.

(1) Engineer boat groups are organized, as described in paragraph 79c (1) and (2), each group consisting of a reinforced engineer squad with four or five assault boats.

(2) Leading infantry units move to the final assembly area where they are met by the engineers who lead boat groups to the boat-group assembly areas. (See fig. 9.) At the boat-group assembly area, each infantry boatload is guided to its boat. The infantry troops assigned to a boat carry it down to the river bank, led by the engineer guide. Upon arrival at the embarkation points, the troops with each boat embark immediately and paddle to the far bank. There they get out, overcome any obstacles found, and neutralize enemy resistance near the bank. Special equipment, such as chicken wire and bangalore torpedoes, may be carried in assault boats by leading elements to facilitate passage of obstacles not eliminated by fire. After neutralizing enemy

resistance near the bank, the leading infantry units advance to the first objective.

(3) Departures from the final assembly areas are timed to

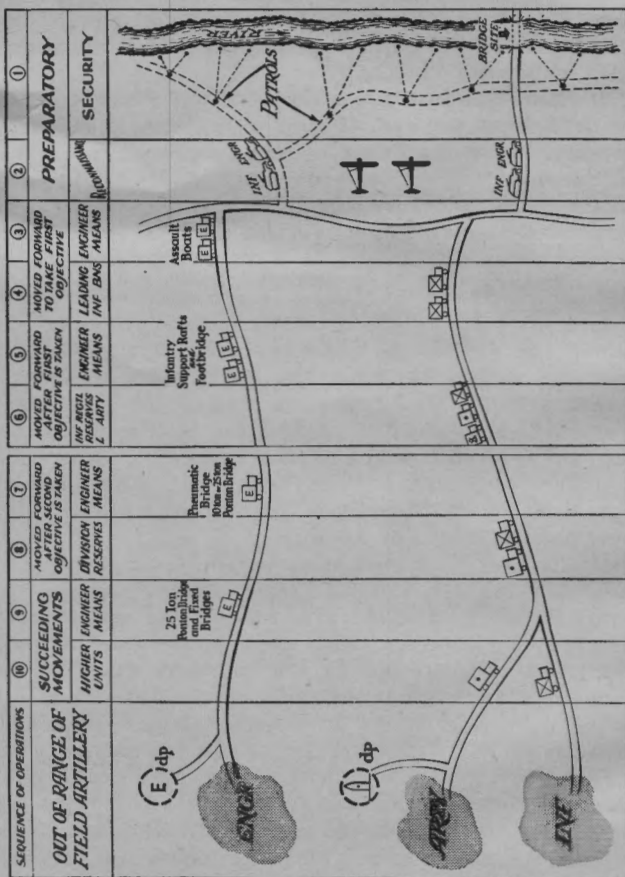


FIGURE 8.—Sequence of operations, river crossing.

permit leading units to cross simultaneously on a broad front, but once these units leave the final assembly areas they do not halt for coordination and no attempt is made to main-

tain alinement between boat groups. In night crossings, firing from boats is prohibited.

b. Handling assault boat.—(1) Ten to twelve men carry the boat. From the time of departure from the final assembly area until the moment the far bank is reached, no

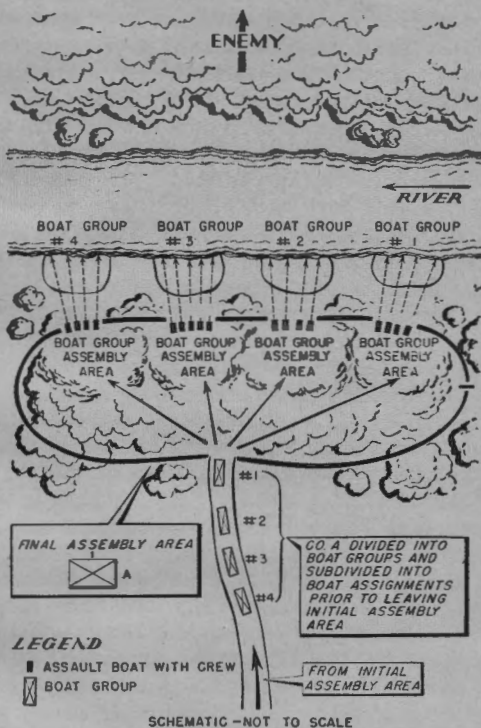


FIGURE 9.—Final assembly area.

unnecessary stops are made. The boat is carried forward inverted, as far as a spot previously selected by the engineer leader within a few yards of the water edge. At this spot the boat is righted. Great care must be exercised to insure that silence is preserved. Objects must not be allowed to

strike the sides or bottom of the boat. Rifles should be slung diagonally, muzzle up, from the shoulder nearest the boat. Special care must be exercised in carrying the boat with its bottom down and every precaution must be taken to prevent it from striking stumps, rocks, and other obstructions and from being dropped or dragged on the ground.

(2) Immediately upon arrival at the river bank, and without change in the carrying formation, the boat is carried bow first into the water until a depth of water sufficient to float the fully loaded boat is reached. The boat is loaded parallel to the bank if the water is deep immediately offshore. Ammunition, machine guns, and other similar weapons or equipment are placed quietly in the boat. The passengers then get aboard, taking care to keep the boat in balance and avoid noise. Two engineer soldiers take position in the bow, one on each side, and the third kneels in the stern. The soldier in the stern is in charge of the boat and does the steering. The infantrymen at the sides paddle the boat, the engineer paddlers in the bow acting as strokes. Paddlers, whose rifles are held by the infantry soldiers not paddling, kneel on their outside knees and use their paddles without touching the sides of the boat. Those not paddling crouch low in the boat, holding rifles upright against the bottom. All men should be prepared to slip off packs in case the boat is overturned or sunk.

(3) Each boat starts across as soon as loaded and is paddled as rapidly as possible to the opposite bank. Unless specific orders to do so have been issued because of the relative positions of available embarkation and debarkation points or the width and current of the stream, no effort is made to counteract drift. Under conditions of complete darkness, heavy fog, or smoke, the proper direction of the boat may be maintained by use of a luminous compass. Upon arrival at the far shore, silence is preserved unless the enemy has discovered the crossing and opened fire. To avoid noise, the boat is not beached, except on a mud bottom. The engineer soldiers in the bow disembark and hold the boat. Paddlers get out and place their paddles quietly on the bottom of the boat. All passengers then step into the shallow water or directly ashore. Cargo is then unloaded. The entire crossing is executed with the utmost rapidity.

c. *Successive trips.*—(1) When losses in men or boats make it necessary, the squad leader reorganizes his boat crews before the group paddles back across the stream. When the boats return close to the near shore, they are paddled upstream to their loading points if return to this point has been ordered. (See fig. 10.) They find the loading points by signals arranged with the engineer guides on shore. The squad leader reports with guides to the engineer platoon commander on landing. Contact is then made with the local

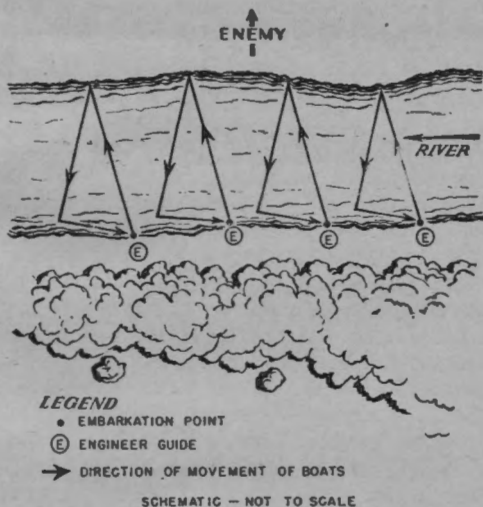


FIGURE 10.—Operation of boat group.

infantry commander who then decides, if he has not already done so, whether to send over the next loads of infantry as each boat group returns or to wait until all boat groups have returned.

(2) When the second load is assigned to a boat group it is guided to the embarkation point by the engineer guide and is crossed in the same manner as in the initial crossing. Infantry assigned to the second and succeeding trips may be required to carry forward to the embarkation point additional assault boats to serve as replacements.

(3) Sometimes it is necessary for the boat crews to return to the near shore at points different from the initial embarkation sites. The decision as to whether or not the boats are to return to their original points of departure is made prior to the crossing and instructions to crews and guides are issued before the first wave leaves.

■ 76. CROSSING FOOTBRIDGES.—Footbridges may be used for crossing leading waves over narrow streams. Their construction is difficult under small-arms fire and they are reserved usually for crossing succeeding waves of foot troops after the first objective has been attained.

■ 77. CROSSING BY INFANTRY SUPPORT RAFTS.—*a.* Infantry support rafts are provided to cross vehicles needed to support the assault waves before it is practicable to use ponton bridges. Rafts can be built and operated as soon as small-arms fire is eliminated from the crossing sites. The rafts can be transported to and employed at sites which could not be reached by the heavier transportation required for the ponton equipage. Vehicles crossed by these means include trucks for carrying infantry supporting weapons, ammunition, and other supplies; a portion of the light artillery needed for close support of the infantry advance; antitank and anti-aircraft units; and medical and signal vehicles.

b. The importance of the infantry support raft in a river-crossing operation cannot be too strongly emphasized. Foot troops crossed by assault boats or other means and unsupported by artillery and antitank weapons will be at a great disadvantage when subjected to vigorous counterattack. Rafts are constructed as soon as small-arms fire has been eliminated from the crossing site, and ferrying of combat vehicles is continuous until bridges are built. Even then use of rafts may be continued for evacuating ambulances and other returning vehicles.

■ 78. CONTINUATION OF THE ATTACK.—*a. Second objective.*—When the first objective has been taken and supporting infantry units have been brought up behind the initial wave, the attack on the second objective is pressed without delay. Since the achievement of this objective will deprive the defender of his ground observation of the river, considerable

resistance may be expected. Artillery support is furnished the attacker both from units which are in their initial positions and from those which have been moved across the river. Protection against attack by mechanized forces is furnished the attacker by antitank weapons and mines in advanced positions.

b. Bridges.—When the second objective has been taken or, before this, if heavy enemy artillery fire is kept from the site by other means, the division or higher commander directs the construction of the bridges. The greater the number of bridges, the quicker and surer the crossing. Principal and alternate sites for each bridge are selected well in advance. Bridging equipment usually is not deposited at the bridge site until the initial phase of the action indicates the site can be used. In the event, however, that bridge matériel has been unloaded at a site subsequently shown to be disadvantageous, the equipment may be moved to an alternate position. Such a transfer is a difficult and time-consuming operation; decision for the action rests with the superior commander.

c. Third objective.—The bridge having been completed, the remainder of the artillery and other troops are crossed, and if the third objective has not already been taken, a coordinated attack is made.

SECTION II

RIVER-CROSSING MEANS

■ 79. ASSAULT BOAT M2 (fig. 11).—*a.* The assault boat M2 is used in crossing the assault waves of infantry. This boat weighs about 410 pounds and has a useful displacement of approximately 4,000 pounds. In addition to its crew of three men, it will safely carry—

(1) One rifle squad (12 men) with individual weapons and combat equipment.

(2) Two light machine-gun squads (ten men) with two caliber .30 light machine guns and 20 boxes of ammunition.

(3) One heavy machine-gun squad (seven men) with one caliber .30 heavy machine gun and 13 boxes of ammunition.

(4) Two 60-mm mortar squads (ten men) with two 60-mm mortars and 72 rounds of ammunition.

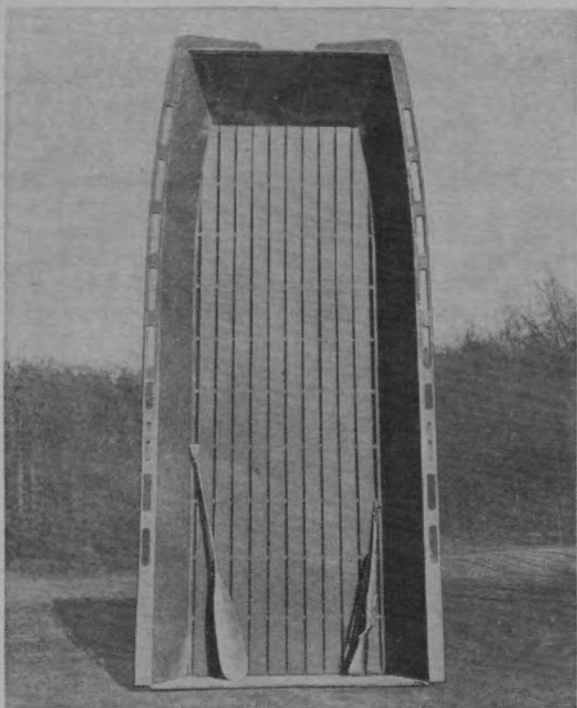


FIGURE 11.—Assault boat M2.

(5) One 81-mm mortar squad (seven men) with one 81-mm mortar and 50 rounds of ammunition.

(6) One 37-mm antitank gun squad (five men) with anti-tank gun and 100 rounds of ammunition.

(7) One infantry communication platoon wire section (eight men) with complete equipment.

b. The assault boat is carried to the site of the crossing, launched, and paddled across the stream by the infantry. Three engineer soldiers are included in each boat to guide the infantry to the crossing point, to occupy key paddling positions, and to return the boat to the near shore. An additional engineer, who acts only as guide, is assigned to the

crew if the boat is to make more than one trip. The guide remains on the near shore to aid the boat crew to return to the embarkation point and to report back and guide the next load of infantry forward to the boat. The assault boat enables infantry to cross with the high degree of secrecy, dispersion, and initial strength essential to a forced crossing. Assault boats cross a river at a rate of about 150 feet per minute in a current of about 2 miles per hour.

c. Assault boats are assigned so that infantry cross in tactical units.

(1) Four boats are required to carry an infantry platoon, one boat for each rifle squad and one for platoon headquarters. (See fig. 12.) These four boats constitute a boat group.

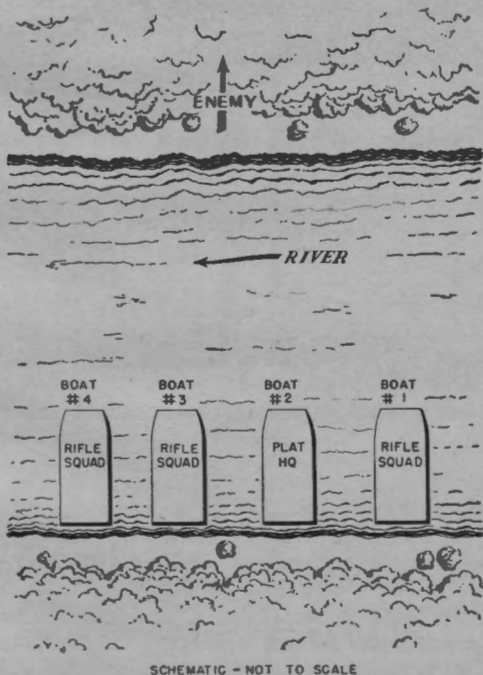
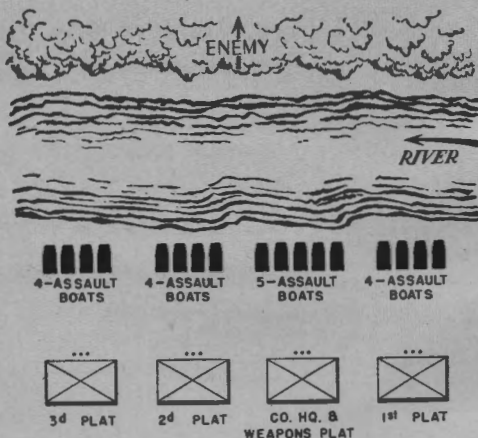


FIGURE 12.—Assignment of assault boats M2 to infantry rifle platoon.

(2) Seventeen boats are required to carry a rifle company of infantry, four boats for each rifle platoon and five boats for company headquarters and the weapons platoon (see fig. 13). The seventeen boats are usually organized into four boat groups, one for each rifle platoon and one for company headquarters and the weapons platoon.

(3) The requirements in assault boats for the heavy weapons company, the battalion headquarters company, and the battalion medical detachment are shown in table V. These



SCHEMATIC — NOT TO SCALE

FIGURE 13.—Assignment of assault boats M2 to infantry rifle company.

units usually cross in the second or later waves. The assignment of boats to groups is made in accordance with the assignments shown in (1) and (2) above.

d. Engineer crews and engineer units are assigned to conform to the tactical grouping of infantry units. In one typical case, used here as an example, the infantry regiment crosses two battalions abreast with the third battalion in reserve. Each battalion crosses two rifle companies abreast in the first wave, heavy weapons company and battalion head-

quarters company in the second wave, and the reserve rifle company in the third or subsequent waves. A suggested engineer assignment is as follows:

(1) A reinforced engineer squad (sixteen men), operates a group of four boats carrying an infantry rifle platoon (see

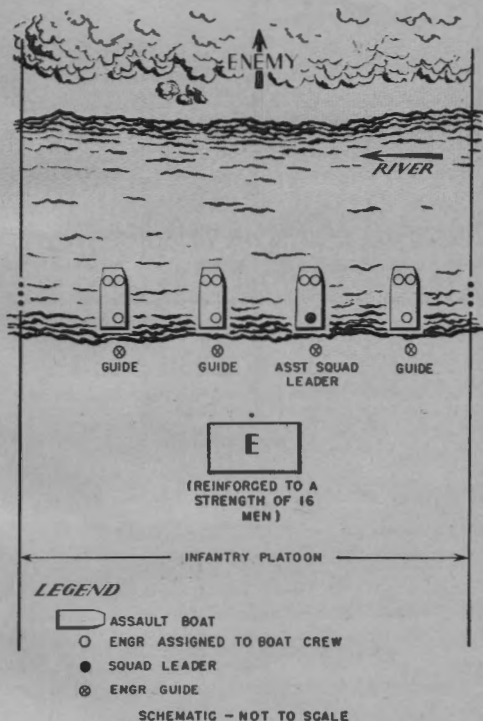


FIGURE 14.—Assignment of engineers to a four-boat group.

fig. 14). Each boat is assigned a crew of three men and a guide who remains on shore.

(2) A squad reinforced to twenty men operates a group of five boats carrying company headquarters and the weapons platoon.

(3) An engineer platoon (reinforced with a second platoon)

is assigned to cross an infantry rifle company (see fig. 15). The six squads of the two platoons are organized into four reinforced squads, each of which operates a boat group under the control of the engineer platoon commander.

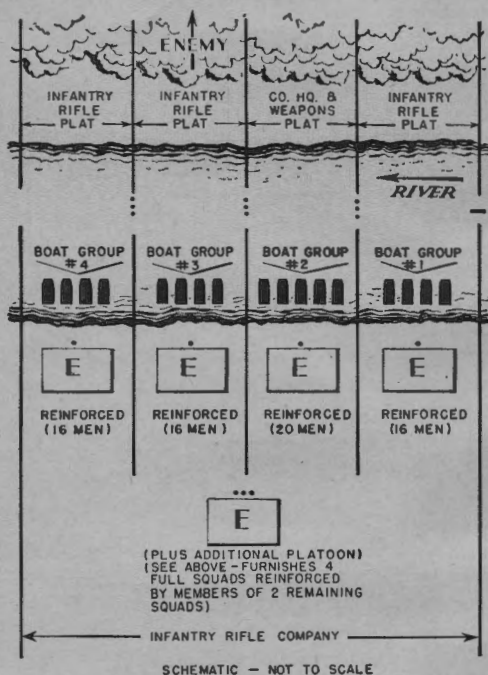
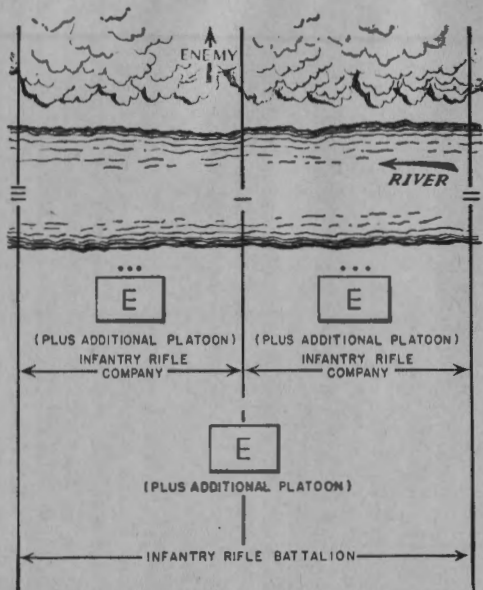


FIGURE 15.—Assignment of engineers to cross an infantry company in assault boats.

(4) An engineer company (with one platoon attached) is assigned to cross an infantry rifle battalion (see fig. 16).

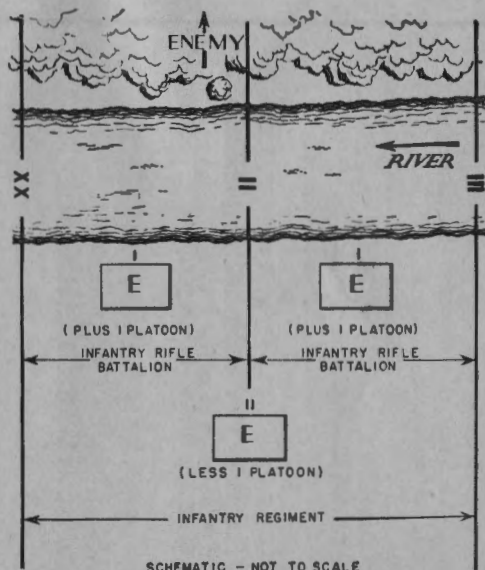
(5) An engineer battalion (less one platoon) is assigned to cross an infantry regiment (see fig. 17).

(6) The foregoing assumes that the engineer battalion is at full strength. If it is not, the entire battalion, including personnel from company headquarters of each company and the



SCHEMATIC - NOT TO SCALE

FIGURE 16.—Assignment of engineers to an infantry rifle battalion in an assault boat crossing.



SCHEMATIC - NOT TO SCALE

FIGURE 17.—Assignment of engineers to an infantry regiment in an assault boat crossing.

headquarters and service company may be required to reinforce the squads assigned to boat groups.

■ 80. ASSAULT BOAT M1 (fig. 18).—*a.* The assault boat M1 is also used at times in crossing the assault waves of infantry. It weighs about 200 pounds and has a useful displacement of approximately 3,200 pounds. It will safely carry in addition to its normal crew of two men—

- (1) Nine riflemen with individual weapons.
- (2) Eight men, one caliber .30 light machine gun, and 20 boxes of ammunition.
- (3) Eight men, one caliber .30 heavy machine gun with tripod, and 13 boxes of ammunition.
- (4) Seven men, one 81-mm mortar, and 48 rounds of am-

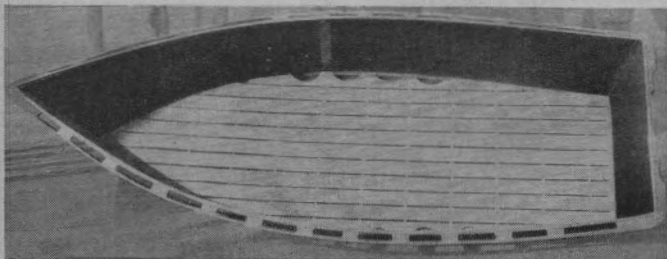


FIGURE 18.—Assault boat, M1.

munition; or nine men, one 60-mm mortar, and 150 rounds of ammunition.

(5) Seven men and the equipment of the advance echelon of the infantry battalion communication section.

b. The operation of this boat is identical with that of the assault boat M2 but only two engineer soldiers are needed as operating crew. This boat is being replaced by the M2 assault boat.

■ 81. PNEUMATIC RECONNAISSANCE BOATS, 6-TON AND 12-TON PNEUMATIC FLOATS.—Pneumatic reconnaissance boats (fig. 19), 6-ton pneumatic floats (fig. 20①), and 12-ton pneumatic floats (fig. 20②) may be used with later waves in a river crossing. Their use with the first wave is undesirable because of the extreme vulnerability of the pneumatic equipment to small-arms fire.



FIGURE 19.—Pneumatic reconnaissance boat.



① 6-ton pneumatic float.

FIGURE 20.



② 12-ton pneumatic float.

FIGURE 20—Continued.



FIGURE 21.—Storm boat.

■ 82. STORM BOAT (fig. 21).—The storm boat, a high-powered motor boat, is used as an assault craft when crossings of very wide streams are made, and when secrecy is subordinated to speed. Its capacity is approximately the same as

that of the assault boat M1. It requires two highly trained engineer operators. Fully loaded it has a speed of about 2,200 feet per minute.

■ 83. FOOTBRIDGE M1938 (fig. 22).—The footbridge is a standard means for effecting the rapid passage of foot troops across a stream. Normally, it is not constructed until the initial covering force has secured a foothold sufficient to

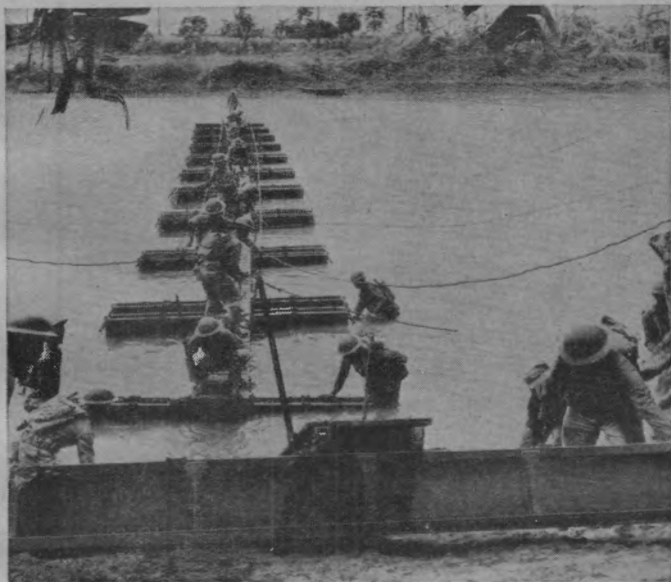


FIGURE 22.—Footbridge.

prevent the enemy from placing direct small-arms fire on the bridge site. The unit of footbridge equipment provides for the construction of 432 feet and is transported on three 2½-ton trucks or four 1½-ton trucks.

■ 84. INFANTRY SUPPORT RAFT (fig. 23).—The infantry support raft is used to ferry vehicles and troops. Each raft carries a load equivalent to one 2½-ton truck fully loaded. It consists of six assault boats M2, which are connected in pairs to

form three floats; eight plywood treadways used as flooring for the raft and as approaches; six siderails; sixteen siderail clamps; one 22-hp. outboard motor; forty-two paddles; and guy lines. Each of the eight ramps weighs approximately 420 pounds and its effective length is twelve feet, excluding the projecting treadway ends by which two treadways are dovetailed together. The infantry support-raft equipment can be employed to construct rafts of several types which have different lengths, capacities, and methods of loading. The raft material of six infantry support rafts can be com-



FIGURE 23.—Infantry support raft.

bined into a ponton bridge approximately 192 feet long. Sixteen treadways not used when such a bridge is constructed, together with the pneumatic floats which are part of the equipment of each platoon, can be used to provide an additional 96 feet of bridge, making a total of 288 feet. Six infantry support rafts can cross a regiment of infantry and supporting artillery in from 3 to 5 hours, except in the case of very wide rivers.

■ 85. BRIDGE, PONTON, PNEUMATIC, M3 (fig. 24).—The M3 pneumatic ponton bridge consists of 250 feet of floating sec-

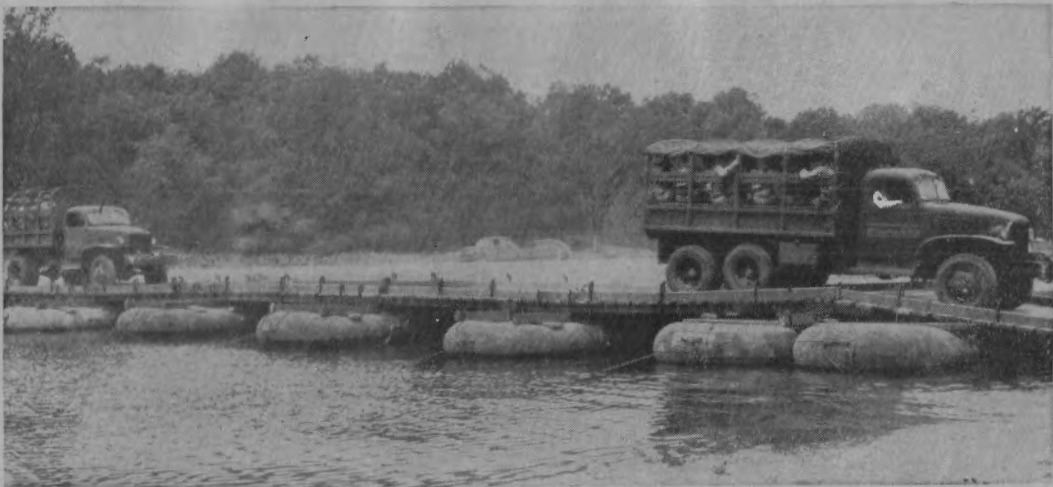


FIGURE 24.—Pneumatic ponton bridge M3.

tion and 75 feet of fixed section. The floating section is supported on 12-ton pneumatic floats.

■ 86. 10-TON PONTON BRIDGE (fig. 25).—The 10-ton ponton bridge (M1938) is an alternate standard ponton bridge with metal pontons and a deck of balk and chess. It has greater capacity in vehicles per hour and will stand up under heavier use than bridges constructed of the pneumatic or plywood equipage. A normal bridge constructed of this equipage will carry all infantry division loads. By the addition of two extra balk in each span it can be reinforced to carry the light tank M3. (See fig. 25.) One unit of this bridge consists of twelve pontons, twelve 12-ton pneumatic floats, four trestles, and necessary balk and chess. It provides sufficient equipage to construct a bridge 214 feet long if four trestles can be used. In bridges employing more than one unit of equipage each additional unit provides 186 feet of floating span. A 20-ton bridge can be built with the 10-ton equipage by adding an additional ponton or pneumatic float in each floating bay, and placing additional balk in abutment-, trestle-, and hinge-span bays.

■ 87. 25-TON PONTON BRIDGE (fig. 26).—The 25-ton ponton bridge (M1940) can be reinforced to carry all military loads except the heaviest tanks. By the addition of two extra balk in each floating span it can be reinforced to carry the medium tank, M3. These two balk are added on the outside edges of the floor system, so the bridge can be reinforced without taking up the chess. By the addition of pneumatic floats or extra pontons and balk, it can be reinforced to carry the M4 tank. As with the 10-ton bridge, one unit of the 25-ton ponton bridge consists of twelve pontons, twelve 12-ton pneumatic floats, four trestles, and necessary balk and chess. It provides sufficient equipage to construct a bridge 210 feet long if four trestles can be used. In bridges employing more than one unit of equipage each additional unit provides 180 feet of floating span. The 25-ton bridge can be reinforced to carry tank loads of approximately 40 tons. This reinforcement is accomplished in the same manner as with the 10-ton bridge.

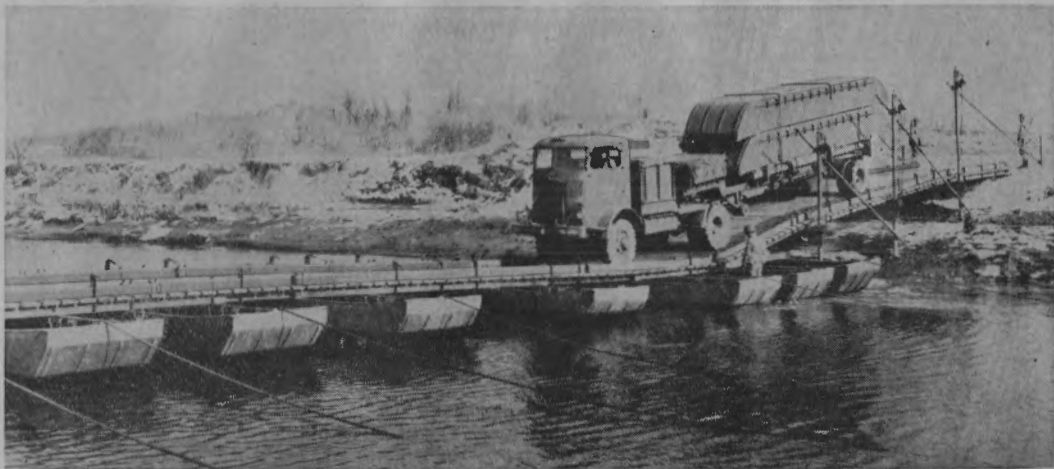


FIGURE 25.—10-ton ponton bridge.



FIGURE 26.—25-ton ponton bridge.

■ 88. **SITE SELECTION.**—An ideal site for any particular type of river-crossing operation is never found. The final choice of site is always a compromise between tactical and technical considerations. The site characteristics discussed below are all desirable, but few are essential.

a. Assault-boat crossing site.—(1) Desirable *tactical* characteristics include—

(a) Location so as best to further tactical plan, convenience to objectives, and good routes of advance into enemy positions.

(b) Broad front; individual boats to be at least 20 yards apart.

(c) Lack of opposition by enemy small-arms or artillery fire.

(d) Local defilade on far bank.

(e) Covered approaches on near bank.

(f) Good positions for supporting weapons on near shore.

(2) Desirable *technical* characteristics include—

(a) Moderate current (1 to 2 miles per hour).

(b) Suitable successive embarkation points downstream.

(c) No obstruction in water area.

(d) Firm banks, free of obstructions; slope not steeper than 2 to 1 and preferably flatter; height not over 6 feet.

(e) At least 20 inches of water 10 feet offshore to prevent grounding of boats.

b. Footbridge.—(1) Desirable *tactical* characteristics are those listed in *b*(1) above.

(2) Desirable *technical* characteristics include—

(a) Proximity to a road, path, fence, or other feature on near shore leading to site.

(b) Cleared area on near shore, either flat or with a uniform gentle slope, large enough for assembly of bridge bays and preferably screened from far bank.

(c) Water adjacent to near bank deep enough to float bridge but not more than waist deep.

(d) Absence, especially on near bank, of high banks or other obstructions.

(e) Presence of trees or other usable anchorages on both banks for float cables and guy lines.

c. Infantry support raft.—(1) Desirable *tactical* characteristics include—

(a) Location on the crossing fronts used by the first echelon, to take advantage of early clearance of small-arms fire from site and to secure protection of ammunition and weapons vehicles when moving forward.

(b) Sufficient distance from other ferry or bridge sites so that artillery fire or aerial bombing directed at one will not destroy the other.

(c) Access to an all-weather road on both sides of river which fits into plan for traffic circulation.

(d) Avoidance of points near which enemy artillery has registered.

(e) Terrain on far bank which provides local defilade from flat-trajectory and artillery observation.

(2) Desirable *technical* characteristics include—

(a) Approach route to site.

(b) Sufficient space to permit two or more rafts to be constructed and loaded with vehicles at same time.

(c) Moderate current.

(d) No obstructions in water area.

(e) Firm sloping banks, free of obstructions; slope not steeper than 2 to 1 and preferably flatter.

(f) At least 20 inches of water 7 feet offshore to prevent grounding of boats (for three- or four-boat raft).

(g) Approach road on far side.

d. Ponton bridge.—(1) Desirable *tactical* characteristics are those listed in *c*(1) above, and also include terrain on both banks which will afford sites and unobstructed observation for a well-organized antiaircraft defense, yet at the same time offer considerable wooded areas and ravines in immediate vicinity of bridge to conceal command posts, headquarters for engineer maintenance, and other tactical and technical installations.

(2) Desirable *technical* characteristics are as follows:

(a) *Approaches.*—Short, easily constructed approach roads from site to existing road net on both sides. Within 150 feet of bridge, approaches should be straight and without excessive grades, particularly on far shore. Prior construction of near approach is often essential in order to get ponton

equipment to river. Time required to construct approaches is frequently controlling factor in selection of site.

(b) *Current*.—Should be steady, parallel to banks, and moderate. Location in a straight reach or gentle bend is favorable.

(c) *Bed*.—Bed of river should be free from snags, rocks, shoals, and other obstructions which interfere with movement of pontoons and erection of trestles and should be sufficiently firm to hold anchors and support trestles.

(d) *Banks*.—Should be firm enough to support sill and approach. They should not be so high or so steep as to require excessive digging for approaches. They should not be so low that slight rises will overflow sites and greatly increase length of bridge required.

(e) *Launching pontoons*.—A 15-foot stretch of bank having a gentle slope to water, either at site or convenient to it, is needed for launching pontoons. In swift current, an upstream point is desirable.

(f) *Mooring pontoons*.—A place is necessary for mooring pontoons along bank about 250 feet from site. Mooring points may be upstream or downstream of site, or both, depending upon plan for casting anchors or for using anchor cable; and upon current. Easy access from land side, deep water, and scattered trees along bank are desirable.

(g) *Stacking balk and chess*.—Cleared area on near shore at site is needed for unloading and stacking balk, chess, and other equipment.

(h) *Transportation park*.—Provision must be made for moving trucks and empty trailers away from site or for parking them nearby under cover.

(i) *Holdfasts*.—In case it is inadvisable to use anchors in bed of river to hold pontoons, presence of large trees or other holdfasts near bank is desirable for fastening steel anchor cables and guy lines. When a bridge is located downstream from existing pile clusters or bridge piers, these may be used as holdfasts.

(j) *Rise and fall of water surfaces*.—In selecting site, effect of normal changes in water level on construction and operation of bridge must be considered. Tides, floods, drought, and destruction or manipulation of dams may change level many feet.

(k) *Demolished bridges.*—Ponton bridge should be located far enough away from site of a demolished fixed bridge so that there will be no interference with its later reconstruction.

(l) *Tributary streams.*—If bridge site is just below mouth of a tributary stream, boats and parts or rafts can be constructed and launched in tributary, under cover, and can then be floated down into position whenever needed.

■ 89. ALLOTMENT OF RIVER-CROSSING EQUIPMENT TO ENGINEER UNITS.—Table III shows the allotment of river-crossing equipment to engineer units. Additional equipment is stocked in engineer depots in the theater of operations and is available if necessary.

TABLE III.—*Engineer river-crossing equipment*

(Subject to change. See latest T/E)

ITEM OF EQUIPMENT	ORGANIZATION						
	Division				Corps	Army and T. H. Q.	
	Com- bat Bn	Squad- ron	Mtz Bn	Armd Bn	Com- bat Bn	Lt Pon Co	Hv Pon Bn
Assault boat M2 (each).....	14	14	14		14	$\left. \begin{array}{l} 146 \\ ^1(72) \\ ^2(4) \\ 70 \end{array} \right\}$	² (8)
Footbridge (unit).....						1	
Infantry support raft (each).....						12	
Ferry set, infantry support (each).....						4	
Pneumatic floats, 6-ton (each).....	18	18	18	20	18		
Pneumatic reconnaissance boat (each).....	15	15	15	20	15		
Storm boat (each).....							16
M3 ponton bridge, pneumatic (unit).....						³ (2)	
10-ton ponton bridge (unit).....						³ (2)	
25-ton ponton bridge (unit).....							4

¹ These boats are ones included in infantry support rafts.² Two per unit of equipage. Until supply is exhausted, these boats may be the M1 type.³ M3 bridge supersedes 10-ton ponton bridge. Metallic ponton procurement is stopped. Existing 10-ton ponton equipage is continued in use until substitution is made.

SECTION III

ENGINEER PLAN FOR OPERATIONS

■ 90. GENERAL.—*a.* The division engineer normally prepares a detailed plan for any deliberate river-crossing operation in which the division engages. This plan estimates the number of engineer troops necessary for each phase of the operation, provides for the attachment of engineer troops and equipment, and assigns engineer troops and equipment to those parts of the operation which are accomplished directly under division control.

b. In order to prepare the engineer plan, the division engineer must know the tactical plan. Sometimes technical engineer considerations are the deciding factor in determining the tactical plan. If such is the case, the division engineer informs the commander as to what tactical plans can be supported with the engineer means available and under the engineering conditions existing. In many cases, however, technical limitations on the most favorable tactical plan can be overcome by securing additional engineer assistance from corps and army.

c. Table IV is designed to aid in the preparation of the engineer plan. This chart is only a general guide, however, and local conditions may cause important variations in the rates of construction and of crossing.

d. There are certain general principles to which the division engineer must adhere in the preparation of any river-crossing plan. These are as follows:

(1) Engineer attachments to leading elements of the division should be sufficient only to provide each of these units with the means necessary for its own operations. Engineer units providing the crossing means for the remainder of the division operate under division control.

(2) In making attachments, provision should be made for the normal association of units and for the prompt reversion of attached engineer units to division control as soon as they have completed the tasks for which attached.

(3) Since fatigue and casualties reduce the effectiveness of a unit, and since it takes time for them to be reorganized, plans should not require units completing one task to be

TABLE IV.—Planning data for river-crossing means ¹

River-crossing means	Objectives to be seized before start of construction	Time of construction ²				Standard construction party ³	Maximum loads	One-way capacity loads per hour per site ⁴			
		Stream widths						Stream widths			
		150 ft.	300 ft.	500 ft.	1,000 ft.			150 ft.	300 ft.	500 ft.	1,000 ft.
Assault boat, M2 ⁵						(Crew—three men)-----	See par. 79-----	4	4	3	2
Footbridge-----	1st	15 min.	20 min.	30 min.		1 platoon-----	Personnel-----	Day—75 men per min. (double time). Night—half day rate.			
Infantry support raft ⁶ (one per site).	1st	10 min.	10 min.	10 min.	10 min.	1 platoon (crew—one-half squad per raft).	Two ¼-ton trucks loaded. One 105-mm howitzer. One 2½-ton truck loaded.	7	6	5	4
Infantry support raft ⁶ (two per site).	1st	20 min.	20 min.	20 min.	20 min.	1 platoon (crew—one-half squad per raft).	do-----	14	12	10	8
Infantry support raft ⁶ (three per site).	1st	30 min.	30 min.	30 min.	30 min.	1 platoon (crew—one-half squad per raft).	do-----	(7)	18	15	12
M3 ponton bridge ⁸ ..	2d					One light ponton company plus one general engineer company.	Loaded 4-ton cargo truck tow 155-mm howitzer.	Over 500 vehicles.			
Reinforced M3 ⁸ ponton bridge.						do-----	Tank loads up to 18 tons.	Do.			

10-ton ponton bridge.	2d	2 hrs.	3 hrs.	4 hrs.	do	All organic infantry division loads.	Do.
Reinforced 10-ton ponton bridge.					do	Tank loads up to 20 tons.	Do.
25-ton ponton bridge.	2d	3 hrs.	4 hrs.	6 hrs.	One heavy ponton bat- talion plus one or two general engineer com- panies.	All corps or army loads ¹ .	Do.
Reinforced 25-ton ponton bridge.					do	Tank loads up to 40 tons.	Do.

¹ Most of these data are designed for staff planning purposes only. Conditions in the field differ widely and allowances must be made.

² Time is from arrival of equipment at site and includes unloading and construction in daylight. For night, increase 75 percent. Estimate does not include preparation of abutments or approach roads. Adequate length of accessible river line is assumed.

³ Parties are general engineer troops unless otherwise stated.

⁴ Two-way capacity of bridges is half that of one-way. Two-way capacity of ferries is about same as one-way. Capacity given is for daylight; for night, decrease by 25 percent.

⁵ Number of trips per hour considers delay in waiting for more passengers to arrive from assembly area.

⁶ Time of construction assumes equipment stacked at site. Average time to land and load, or unload, each raft is 4 minutes; speed of raft empty is 7 mph; speed of raft loaded is 5 mph.

⁷ Not practicable for this distance, as ferries will interfere with one another.

⁸ Construction times to be determined.

⁹ With two extra balk (total twelve) per bay, bridge will carry M3 medium tank. Additional reinforcement is required to carry M4 medium tank.

placed immediately on another task. The plan should provide for at least a nucleus of fresh engineer troops for each major engineer task.

(4) Unity of command must be maintained as far as practicable; for example, an attachment should consist of a battalion less a company, not two companies, or of a company with one platoon attached, not a company and a platoon.

(5) Provisions should be made for engineers to carry on essential-engineer work in rear areas during the crossing and to assist the advance on the far side by overcoming obstacles and doing emergency work on roads.

(6) Men and equipment should be held in reserve to replace losses and to provide means for exploiting successes. Within the division this reserve usually should be equal at least to one-third of the minimum requirements of the proposed plan. The reserve is rotated so that units completing tasks revert to reserve to replace fresh units being employed on later tasks.

■ **91. ILLUSTRATIVE SITUATION.**—The development of an engineer plan to support the crossing of an infantry division in a relatively simple situation is outlined below.

a. Technical situation.—The stream to be crossed is 400 feet in width, with an average current of 2 miles per hour. Its banks are such that assault boats can be used at almost any desired point. One main road in the division area crosses the stream, but the road network is such that at about five points vehicles can reach the stream and leave it on the far side. The approaches at the ponton-bridge site can be prepared within the time available by an engineer platoon.

b. Tactical considerations.—The plan is to make the initial crossing on a broad front with two regiments abreast. Each regiment is to cross two battalions abreast in assault boats. The vehicles are to be crossed on infantry support rafts, and the third battalion and other foot elements are to cross either on a footbridge or on infantry support rafts. At least two firing batteries of each of two light artillery battalions are to be crossed on infantry support rafts. The third infantry regiment, the remainder of the division artillery, and the remainder of the division are to cross on an M3 pneumatic ponton bridge. There are no obstacles on the far side of the stream important enough to necessitate the attachment

of engineers to accompanying the four leading infantry battalions in the advance on the far shore.

■ 92. ASSIGNMENT OF ENGINEERS TO ACCOMPANY INFANTRY ADVANCE.—The division engineer decides to attach one platoon of engineers to each infantry regiment to accompany it in the advance. Each platoon is to cross itself in three assault boats upon call from the commander of the infantry regiment.

■ 93. ASSIGNMENT OF ASSAULT BOATS WITH CREWS.—The next problem that the division engineer considers is the assignment of assault boats and their engineer crews to the two leading regiments.

a. After consultation with the general staff, the division engineer plans to provide 34 boats to cross each infantry battalion (with customary detachments of artillery and medical personnel) with two rifle companies abreast and one in reserve. The boats are utilized as follows (see table V for details):

In the first wave:

Seventeen boats to first rifle company.

Seventeen boats to second rifle company.

In the second wave (any twenty-one of the thirty-four):

Fifteen boats to the heavy weapons company.

Two boats to detachment battalion headquarters company.

In subsequent waves, as boats become available:

Nineteen boats to reserve rifle company and battalion medical detachment.

Five boats to battalion headquarters company, less detachments.

b. The allotment, together with three boats for the engineer platoon which accompanies the infantry advance, will be 71 boats to each regiment, or 142 to the division. The requirement in engineer troops is one battalion less a platoon (see par. 79) for each infantry regiment.

■ 94. CONSTRUCTION OF FOOTBRIDGE.—The division engineer decides to provide a footbridge for each of the two leading regiments. For the construction of each there will be provided an engineer platoon.

TABLE V.—*Infantry rifle battalion in a river crossing*

Typical loadings using assault boats M2 (half-boats)

UNIT	T/O strength (including basics)		Members not crossing with unit	Nonmembers crossing with unit	Total men crossing	Number of assault boats allotted
	O	EM				
<i>One rifle company</i>						
1st platoon (rifle) . .	1	45	1 msgr, 5 basics	1 aid man	41	4
2d platoon (rifle) . .	1	45	1 msgr, 5 basics	1 aid man	41	4
3d platoon (rifle) . .	1	45	1 msgr, 5 basics	1 aid man	41	4
Co hq.	2	19	15 (2d in comd of Co, supply sgt., 2 msgrs) 4 cooks, 3 cooks helpers, orderly mess sgt, clerk arm-art.	1 FA fwd obs, 1 FA radio opr, 4 msgrs from platoons.	12	1
Weapons platoon . .	1	38	7 (T cpl, 2 cfrs, 1 msgr, 3 basics).	6 (2d in comd of Co, supply sgt, FA sgt, FA pvt, 2 Co msgrs).	38	4
Total: Company	6	*192	40 (including basics)	15	173	17
<i>One rifle company</i>						
Total: Company	6	192	40	15	173	17
<i>Heavy weapons company</i>						
Co hq.	2	29	21 (mess sgt, T sgt, 4 cooks, 2 cooks helpers, mech, clk, arm-art, 2 cfrs, orderly), 7 basics.	7 (3 msgrs, 4 FA recon os party).	17	2
1st cal. .30 MG plat.	1	44	10 (T cpl, 5 cfrs, 3 basics 1 msgrs).	1 aid man	36	3
2d cal. .30 MG plat.	1	44	10	1 aid man	36	3
81-mm mortar plat.	1	61	12 (T cpl, 7 cfrs, 3 basics, 1 msgr).	8 (1 A&P sq.)	58	7
Total: Heavy weapons . .	5	178	53	17	147	15

*Including basics.

TABLE V.—*Infantry rifle battalion in a river crossing—Con.*

Typical loadings using assault boats M 2 (half-boats)—Continued

UNIT	T/O strength (including basics)		Members not crossing with unit	Nonmembers crossing with unit	Total men crossing	Number of assault boats allotted
	O	EM				
<i>Battalion headquarters company</i>						
Bn hq.....	4	16	5 (3 cfrs, 2 basics).....	4 (S-1, surg, 1 radio opr, 1 msgr).	19	¹ 2
and						
Co hq, bn hq co....	2	20	18 (T O, mess sgt, motor sgt, mech, cfr, 2 orderlies, 3 cooks, 2 cook helpers arm-art, clerk, 4 basics).	0.....	4	—
<i>Communication platoon:</i>						
Wire sect.....	0	10	2 cfrs.....	—	8	1
Hq and msg center sect.	1	11	4 (basic, 2 cfrs, msgr).....	4 (FA liaison officer's party).	12	1
Radio and visual sect.	0	7	3 (2 cfr, radio opr).....	3 (rifle plat commander, plat sgt and msgr).	7	1
Total: Communication platoon.	1	28	9.....	7.....	27	¹ 3
Ammunition and pioneer platoon.	1	28	11 (2 cfrs, 1 basic, 1 sq with Hv W Co).	0.....	18	¹ 2
Total: Bn hq co.	8	92	43.....	11.....	68	7

¹ 1st wave.² 2d wave.

TABLE V.—*Infantry rifle battalion in a river crossing—Con.*

Typical loadings using assault boats M2 (half boats)—Continued

UNIT	T/O strength (including basics)		Members not crossing with unit	Nonmembers crossing with unit	Total men crossing	Number of assault boats allotted
	O	EM				
<i>Reserve rifle company</i>						
1st platoon (rifle)	1	45	1 msgr, 5 basics	1 aid man	41	4
2d platoon (rifle)	1	45	1 msgr, 5 basics	1 aid man	41	4
3d platoon (rifle)	1	45	1 msgr, 5 basics	1 aid man	41	4
Co hq	2	19	15 (2d in comd of Co, supply sgt, 2 msgrs), 4 cooks, 3 cook helpers, orderly, mess sgt, clerk, arm-art).	4 msgrs from platoons.	10	1
Weapons platoon	1	38	7 (T cpl, 2 cfrs, 1 msgr, 3 basics).	4 (2d in comd of Co, supply sgt, 2 Co msgrs).	36	4
Total: Company.	6	*192	40 (including basics)	11	169	17
<i>Battalion medical detachment</i>						
Bn med det	2	36	19 (Bn surg, 13 Co aid men, 2 cpls, 3 basics).	0	19	2

*Including basics.

■ 95. INFANTRY SUPPORT RAFTS.—The antitank platoon is usually crossed on infantry support rafts. In addition, there are approximately 260 vehicles in an infantry regiment. Approximately 150 of these vehicles are essential on the far bank in the early stages of a river crossing, before a ponton bridge can be completed. Therefore, the engineer plan must provide for crossing the bulk of the vehicles in the two leading

regiments by means of infantry support rafts. The plan adopted provides for constructing three rafts in the area of each battalion, the three rafts to be operated from one site. One platoon will prepare the approaches and construct and operate the rafts at each site. Therefore two engineer platoons are to be provided each of the two leading regiments.

■ 96. M3 PNEUMATIC PONTON BRIDGE.—The pneumatic ponton bridge will be constructed as near as practicable to the point where the main supply road crosses the stream. It will be built under division control by the two light ponton companies assisted by a general engineer company (attached).

■ 97. RECAPITULATION OF REQUIREMENTS.—*a. Working forces required.*—The engineer plan for the various phases of the crossing are summarized as follows:

<i>Crossing means</i>	<i>Engineer units required</i>	<i>Attached to infantry</i>
142 assault boats*—	2 combat bns. (ea. less 1 plat.)	Yes
2 footbridges_____	2 platoons_____	Yes
12 infantry sup- port rafts.	4 platoons_____	Yes
1 M3 pneumatic ponton bridge.	2 light ponton companies and 1 combat com- pany.	No

*Includes six boats assigned to two engineer platoons accompanying infantry advance.

To provide the above outlined troops and equipment, the division engineer tentatively plans to request that two combat battalions and two light ponton companies be attached to the division. The two attached battalions will supply the troops for assault boats and footbridges. The division battalion will furnish the two platoons to accompany the infantry advance, and four platoons for the infantry support rafts. The two light ponton companies will supply sufficient ponton equipage to bridge the river and provide the required reserve. One of the companies of a combat battalion assigned to assault boats will, upon conclusion of the assault-boat crossing, be assigned to assist the ponton companies in constructing the ponton bridge.

b. Reserve troops.—At the beginning of the operation, the division engineer has one company of the division engineer battalion in reserve. After the assault-boat phase is completed, the two battalions (each less a platoon assigned to construction of footbridges) revert to division control and become reserves. Upon completion of the footbridges, the two constructing platoons revert to division control and become reserves. The division engineer decides that his tentative plan provides sufficient reserves of troops.

c. Reserve equipment.—(1) The reserve of river-crossing equipment should be one-third of the basic minimum. The total equipment available in the three combat battalions and the two light ponton companies is as follows:

342 assault boats (144 of which are part of the infantry support rafts).

2 units of footbridge (432 feet each).

24 infantry support rafts.

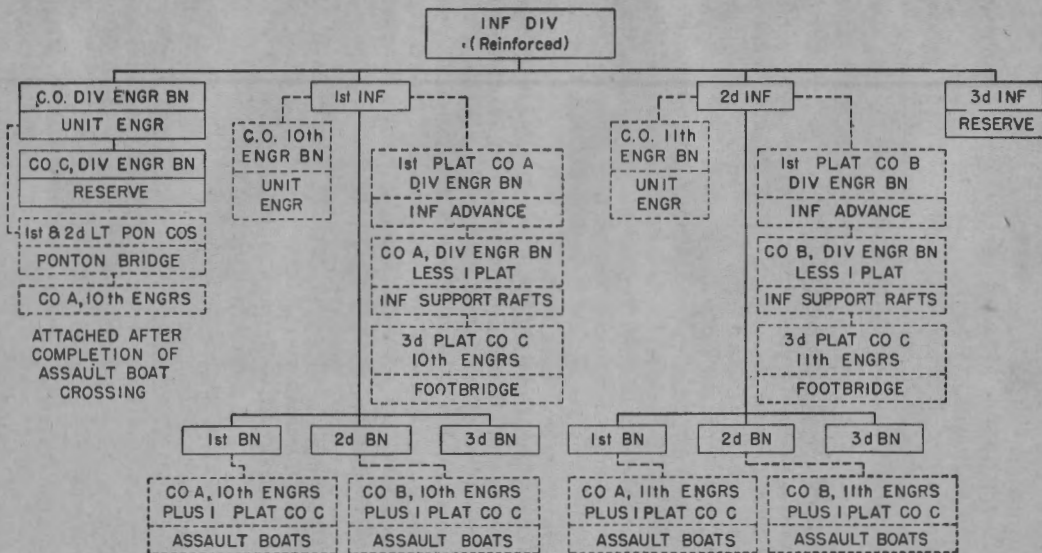
4 units of ponton bridge.

(2) A comparison with the requirements given above shows that the tentative plan of the division engineer provides a sufficient reserve of equipment, except for the footbridges. He requests through the corps engineer one additional unit of footbridge.

■ 98. ASSIGNMENT OF ENGINEER TROOPS AND EQUIPMENT.—Keeping in mind the principles stated in paragraph 76, the division engineer plans to make the following assignments of engineer troops and equipment (see fig. 27).

a. To one of the two infantry regiments making the initial crossing he plans to attach one Corps Combat Battalion. Attached to this battalion will be Co. A, Division Engineer Battalion; six infantry support rafts, 60 additional assault boats and one unit of footbridge from one of the light ponton companies. This method of attachment will provide a complete engineer battalion to cross each of the leading regiments in assault boats and to construct footbridges and an attached company of divisional engineers for constructing and operating the infantry support rafts and to provide a platoon to accompany the infantry advance.

b. To the other infantry regiment making the initial crossing the division engineer plans to make similar attachments (see fig. 27).



LEGEND
 ——— NORMALLY ASSIGNED - - - - - ATTACHED
 FIGURE 27.—Organization for a river crossing.

c. For the construction of the ponton bridge, the light ponton companies will be used, with Co. A of one of the corps combat battalions attached effective upon completion of assault boat crossing.

d. Co. C, Division Engineer Battalion will be in general reserve, with a view to its eventual employment on the main supply road on the far side of the river.

■ 99. REVERSION OF ENGINEERS TO DIVISION AND CORPS CONTROL.—a. The two corps combat battalions should revert to division control when the foot elements of the two leading regiments have crossed the stream. The division engineer recommends that the orders for the attachments include the provision as to when the two battalions will revert. He plans to leave the two companies of the combat battalion attached until the bulk of the division has crossed the stream and the division commander is in a position to coordinate the attack. These two companies will cross the stream with the regiments to which they are attached, leaving the raft equipment at the stream when no longer needed.

b. The corps combat battalions will remain under division control until the ponton bridge is completed, unless the corps commander requires the return of part of them sooner. The two light ponton companies will remain under division control until the last elements of the division have passed over the ponton bridge. At this time these two companies will revert to corps control.

■ 100. ASSIGNMENTS.—a. *Attachments to infantry.*—It is undesirable to mix units, as was done in providing the engineer attachment to each of the two assault infantry regiments. However, it is more important to have the division engineer company attached to the infantry regiment with which it is normally associated. This arrangement permits the corps combat battalions attached to the infantry regiments to revert to division control when the assault-boat crossing is complete. The commander of the corps combat battalion is the unit engineer of the regiment until the assault-boat phase is completed, at which time he is replaced by the commander of the division engineer company attached to the regiment.

b. Employment of units with raft and bridge equipment.—The assignments given provide division engineer units to construct all the infantry support rafts. A ponton unit has primary responsibility for construction of the ponton bridge and is assisted by a company of combat engineers from a corps combat battalion.

c. Provisions for carrying on normal engineer tasks.—Some work must be executed on the near side of the river for supply of water and engineer materials and for maintenance of communication. The bulk of this work can be performed by troops of the corps combat battalions, most of whom pass into the reserve after completion of the assault-boat crossings. The company of division engineers held in reserve, initially, is to be employed to open the main supply road on the far shore.

CHAPTER 6

OPERATIONS UNDER SPECIAL GEOGRAPHICAL CONDITIONS

	Paragraphs
SECTION I. Cold climates.....	101-108
II. Jungle operations.....	109-116
III. Desert operations.....	117-126
IV. Mountain operations.....	127-133

SECTION I

COLD CLIMATES

■ 101. GENERAL.—*a.* Successful conduct of military operations in cold climates requires adjustment to darkness and cold during the long winter; to extensive bogs and insects during the summer; and during the entire year to isolation, inadequate communication, and absence of many supplies common to temperate regions.

b. The first duty of an engineer officer assigned to a cold climate is to learn the peculiarities and characteristics of the region. Upon that knowledge depends the success of the missions assigned him and the welfare and lives of his men.

c. The conduct of military operations during the winter in cold climates is dependent, fundamentally, upon two things: first, suitable clothing and equipment; and second, thorough training of officers and men in how to care for themselves, their weapons, and their transportation. Regardless of temperature, basic tactical doctrines remain the same.

d. Detailed information of military operations in cold climates during the winter is given in FM 31-15.

■ 102. ENGINEER AND ELECTRICAL EQUIPMENT.—*a.* Oil in hydraulic systems of some bulldozers and road graders becomes sluggish in extreme cold and must be replaced with lighter grades. Heated cabs for operators must be provided. Air compressors, air hoses, and air tools become clogged with ice due to condensation and freezing of moisture. Clogging is prevented by special drainage attachments or by frequent

thawing and drainage. Water-purification equipment must be insulated against extreme cold or operated in heated inclosures.

b. Most military explosives except dynamites are nonfreezing. Dynamites are subject to freezing and are exceptionally sensitive when frozen. Safety fuze and detonating cord become stiff in extreme cold and must either be kept in a warm place or handled with unusual care to avoid detonation.

c. Because of congealed oil on bearing surfaces, hand generators and other mechanically operated electrical devices sometimes fail to function satisfactorily at low temperatures. Thin oil or graphite on the bearings will improve their performance.

■ 103. CARE OF MOTOR VEHICLES.—a. Moisture from the air condenses on inner surfaces of gasoline tanks and containers and eventually freezes in gasoline lines and carburetors. This can be partially corrected by keeping containers full. Before gasoline is used in vehicles, it should be filtered through chamois to remove water.

b. Motor vehicles which fail to start sometimes can be started by pulling or pushing. In difficult cases the radiator fluid should be drained and heated, then replaced; the intake manifold heated with a blowtorch; the engine turned over several times with a hand crank; and finally the self-starter applied or the vehicle towed. In extremely cold weather, crankcase oil should be drained upon halting and heated and replaced upon starting.

c. When halted, it is better to chock the wheels than to set the brakes, as the brakes may freeze tight. Air tanks on air brakes must be thawed frequently and drained. Rubber air hose and brake-fluid tubes become stiff and hard and require constant inspection for leakage.

d. Storage batteries are less efficient when cold. Oversized or double batteries are desirable.

■ 104. TRANSPORTATION.—a. When the snow reaches sufficient depth, wheeled vehicles give way to the track-laying type and to sleds. Several sleds can be pulled by one motor vehicle; lacking these, one sled can be pulled by a two- or three-man team. For movement on foot, troops equipped with

snowshoes can maintain a rate of march comparable to that attained by foot troops on terrain not covered by snow. Although not as speedy as skis, snowshoes are better for towing sleds, for climbing hills, and for taking a firing position.

b. Snow greatly reduces mobility and, consequently, the effectiveness of reconnaissance vehicles. Ski patrols offer an effective substitute, since they move silently and rapidly.

c. Keeping roads clear of snow constitutes an important engineer task. Snowplows pushed in front of 4- or 6-ton trucks and followed by truck-drawn harrows for leveling the surface constitute the most effective means of keeping roads open. Good results may also be obtained by the use of hand shovels. When available, civilians may be used for shoveling, thus releasing troops for other duties. Snow is prevented from drifting over the road by erecting snow fences at points where the wind has an unobstructed sweep, and particularly where the road passes through a shallow cut.

d. In spite of road-clearing activities, many vehicles will slide off to the side and be unable to regain the road under their own power. Drivers should be familiar with methods of starting stalled vehicles and extricating stuck vehicles.

e. Tractors are the most reliable means of transportation. They can run through deep snow and over difficult terrain, and can climb steep slopes. They may be used to pull weapons, sleds, and trailers. In going down steep slopes, towed sleds may be braked by wrapping chains around the runners or by having men hold them back with the aid of ropes attached to the rear of the sled. In general it is easier for the tractor to pull its trailing load through snowdrifts than to clear roads through them.

f. Dog teams are useful. Under extremely favorable conditions, a seven-dog team can travel 50 miles in a day. Under average conditions, the performance is more likely to be 10 to 20 miles a day. The chief disadvantages of using dogs are that they must be fed whether on the move or not, and their frequent barking discloses their presence to the enemy.

g. Ski-equipped airplanes may land on open level stretches of snow. Wheel-equipped airplanes can use the frozen surfaces of lakes and streams at places where the snow has been swept clear by the wind or cleared by angledozers.

h. Frozen streams frequently can be used as highways, but ice, especially snow-covered, is treacherous, and must be carefully reconnoitered.

■ 105. MARCHES.—*a.* Winter marches of units will be slower than those in summer. Snowplows should be well forward in the column, with some attached to the advance guard. Heavy vehicles are more satisfactory than light ones for breaking trail. Scout cars can break trail at 15 to 20 miles per hour up to a snow depth of 14 inches. Mechanical strain as well as driver fatigue requires that the leading car be changed frequently. When the trail is broken by foot troops the leading man should be relieved every 20 minutes.

b. For snow more than 1 foot deep, snowshoes or skis are required. If there is a possibility of deployment from a cleared road into deep snow, troops should carry their snowshoes on their backs. Ski detachments average about 6 miles an hour under excellent conditions. An average daily march for ski troops is about 30 to 40 miles per day. Sixty miles is about the maximum. Ski troops ordinarily move cross-country faster than foot troops on the road, consequently ski detachments may be used advantageously for flank patrols. The advance guard should include ski troops in order that the flanks of any hostile force encountered can be located quickly.

c. When climbing hills, brief halts are necessary to permit the column to close up. During rest periods, men should not be allowed to sit on snow. Packs should be used as seats if no snow-free place can be found. Men should sit back-to-back for warmth. During long marches, a rear detail under a noncommissioned officer should be assigned to assist in the repair of skis and bindings.

d. During muscular exertion which produces sweat, men must open the outer garments, permitting air to circulate and carry away excess moisture. If this is not done, casualties will be caused by the underclothes becoming soaked with perspiration and freezing.

■ 106. MAKING CAMP.—*a.* Every effort should be made before dark to pitch camp, to post security detachments, and to gather firewood. Since men are less alert when cold, double

sentries should be the rule, and reliefs should be changed as often as every half-hour.

b. Where tents are to be pitched, the snow should be cleared off and replaced with straw, hay, or branches to keep bedding dry. Snow banked around the lower edge of the tent wall will keep the wind from blowing under it.

c. The presence of moisture near the body in any form is the main cause of chilling. Going to bed in a sleeping bag wearing frosted clothing is a sure way of becoming chilled. If facilities are available, all frosted outer garments should be dried.

d. Camp should be broken after daylight to avoid losing articles in the snow.

■ 107. CAMOUFLAGE.—a. Concealment in snow-covered terrain presents a special problem. Ordinary uniform clothing makes a sharp silhouette; shadows and tracks show up very clearly. Clothing of an off-white color, including capes, should be issued. In order to allow observation while maintaining concealment of fox holes or weapon positions, they may be covered with cloth of a coarse weave or netting. Smooth cotton sheeting or similar materials reflect too much light to be satisfactory.

b. Tracks in the snow show up conspicuously from the air, but if a position is to be occupied for some time they cannot be avoided. In this situation, additional tracks should be designed to lead to decoy positions or to join other track patterns.

c. In open terrain, buildings and installations cannot be completely concealed, mainly because of the long shadows cast, and must be dispersed.

d. Concealment of vehicles in partly snow-covered terrain is aided by painting a disruptive black pattern on a pure white background. This breaks up the outlines of the vehicle, makes it difficult to identify, and causes it to blend with bare rock outcroppings and shadows. When a vehicle is halted, generally a fish net will conceal it against ground observation but not from the air. Tracks make all vehicles difficult to conceal from air observation.

■ 108. ENGINEER OPERATIONS.—a. Need.—Because of adverse climatic conditions, deficiencies of communication and sup-

ply, and absence of many installations common to temperate regions, there is great demand for engineer work in cold climates. Engineer units are usually taxed to the utmost so unit commanders and staffs must plan with extreme care so that maximum results may be obtained.

b. Maps.—Many maps of cold-climate areas are inaccurate. Existing maps often locate landmarks and permanent bench marks accurately, but intervening terrain features only approximately or not at all. The elevations of most mountain peaks and of some localities on shore lines are exact, but contours are approximate or nonexistent. Photomaps and aerial photographs must be used, with sketches or rough maps of specially important areas. Important features to show are water-supply points, gravel pits, fords, river-crossing points, standing timber, camp sites, buildings, advanced landing fields, defensive installations, and other necessary areas or terrain features. More accurate surveying technique must be applied in certain situations, for example, the lay-out and construction of first-class landing fields.

c. Water supply.—In extremely cold weather, portable water-supply units are useless. Under these conditions water is obtained by melting snow or ice which must be boiled before using.

d. Transportation by water.—With the exception of airplanes, water offers the best and, at times, the only means of transportation. Accordingly, engineers must be proficient in handling, repairing, and navigating all types of boats and rafts. Rafts are particularly useful for moving stores and heavy equipment from ship to shore. Ponton rafts can be used for this purpose only when the water is deep enough to prevent their becoming grounded. Large wooden barges with protected bottoms are more suitable. When a locality is occupied, landing docks are among the first installations that must be constructed.

e. River crossings.—Ravines and shallow streams may be bridged by standard or log-trestle bridges. If the stream carries much floating ice, the upstream side of each trestle bent must be protected by piers. In summer deep streams are crossed by ponton bridges. Frequently, frozen streams can be used for crossings without reinforcing the ice. How-

ever, the crossing points selected must be carefully reconnoitered to be certain that the ice is strong enough to bear the loads. Thin ice can be reinforced by placing poles, branches, plants, or straw on it and pouring water over them to freeze. In this operation, small dams are constructed below the area to be reinforced, to retain the water until it is frozen. After freezing, a stream may fall, leaving an air space under the ice which causes it to cave in when weight is placed upon it. This type of ice cannot be reinforced by the method just described. A stream that is just beginning to freeze over or one on which the ice is beginning to break up is extremely difficult to cross. Under these circumstances the only practical methods are by cableway or raft.

f. Roads.—(1) In winter much of the engineer work consists of removal of snow and other similar road blocks. In some instances, engineers may be equipped with truck-mounted snowplows. Angledozerers are extremely valuable to remove snow and to push or tow wheeled vehicles over bad spots. Frequently snow-removal operations must be supplemented by spreading on thin layers of sand at intersections and curves and on steep slopes. Salt or calcium chloride may be mixed with the sand to prevent it from freezing before it is applied.

(2) When deeply frozen ground begins to thaw, it offers great difficulties to transportation. Unpaved roads become quagmires and, except on surfaced roads, wheeled transportation stops. During thaws, vehicle traffic even over surfaced roads must be carefully controlled so that the subgrade will not give way. Gravel is plentiful in many areas. Roads through bog areas may be constructed of corduroy, trestle, plank, or gravel. Sometimes it is necessary to remove the bog material down to hard ground before filling in with gravel. An excellent permanent road may be constructed over some deep swamps by laying corduroy as a base and surfacing with gravel until the road becomes stabilized.

g. General construction.—When permanent camps are built, engineers are employed extensively to construct barracks, warehouses, shelters for communication and power equipment, hangars and docks, and to install power and electric lines, water mains, and sewers. Most buildings used

are prefabricated. Digging of excavations and the laying of concrete in freezing weather are special construction problems. Power hammers if available are of great assistance. Digging is facilitated by building wood fires over areas to be excavated. In freezing weather, concrete must be mixed with heated aggregate and placed on a warmed subgrade. It may be kept warm by steam and proper insulation until it has set properly.

h. Engineer supply.—During favorable weather, engineer supplies should be accumulated and deposited in dumps throughout the area of operations. This is particularly necessary for road material, such as gravel and corduroy. Unusually large quantities of explosives are required to break up ice and frozen ground and for many other purposes for which explosives are not required in temperate weather. They should, therefore, be stocked in large quantities.

i. Field fortifications.—When a base or fortified locality is initially occupied, engineers are usually required to lay out and construct obstacles, emplacements, and protective shelters. As for all construction, frozen ground is the principal difficulty encountered. It increases enormously the amount of labor required. A machine-gun emplacement, for example, normally requires only a few hours to construct, but when the ground is frozen the same operation may take 3 to 4 days.

j. Obstacles.—(1) Deep snowdrifts stop vehicles, and artificial obstruction of roads and defiles may be effected by piling up snow with angledozer. Bare roads on grades and curves can be flooded with water, which, when frozen, presents a serious obstacle to wheeled vehicles.

(2) Frozen lakes and water courses may be turned into obstacles by breaking up the ice with explosives. Best results are obtained by detonating the charges just before the arrival of the enemy. Overflows may be created by damming small streams. Shallow water on top of ice may cause hostile troops crossing it to wet and later freeze their feet.

(3) Antitank obstacles such as pits, trenches, and posts are difficult to prepare in frozen ground. Frequently the holes must be blasted out with explosives. If the ground is not too deeply frozen, the crust can be broken up with air-compressor drills, and the rest of the digging done by troops with hand tools. Antitank mines must be placed on a solid

surface to insure detonation when tank treads roll over them. A hole may be dug in the snow to the depth of the frozen ground surface, the mine placed, and the hole filled again with snow. Due to the cushioning effect of an overlying blanket of snow, it may be necessary to prepare the fuze so that less than ordinary pressure will detonate the mine.

(4) The value of obstacles is greater in snow and extreme cold, because bypassing often is more difficult and cold decreases the capacity of men to remove them.

SECTION II

JUNGLE OPERATIONS

■ 109. GENERAL.—The jungle presents a new type of terrain to the American soldier. The climate, plants, animals, and people are different from those to which he is accustomed. It is therefore necessary that he become familiar with these new conditions in order to care properly for himself and his men, and take full advantage of those features which most favor the accomplishment of his mission. Jungle conditions and the conduct of military operations under them are described in detail in FM 31-20.

■ 110. PREPARATION FOR JUNGLE SERVICE.—It should be emphasized strongly that for a properly trained man, travel and warfare in the jungle are no more difficult or hazardous than in many wooded areas of the United States. The preparation of troops for jungle service includes both instruction and acclimation.

a. Instruction.—All personnel must be instructed in the special sanitation and hygiene measures imposed by the jungle. These are described in FM 31-20, 8-40, and 21-10. The men should know the poisonous plants and animals of the area and must be instructed in the vegetable and animal life. They should be experts in finding their way. This requires thorough instruction in map reading and use of the compass. Due to the heavy cover and limited visibility in jungle areas, combat is carried on largely by small groups acting independently. This places great responsibility on small-unit commanders.

b. Acclimation.—Inhabitants of temperate zones, when first arriving in the Tropics, require a period of adjustment of 6 to 8 weeks to the increased heat and humidity and greater power of the sun.

■ 111. CLOTHING AND EQUIPMENT.—Clothing and equipment receive hard use in the jungle. The woolen olive-drab shirt, khaki trousers, canvas leggings, field shoes, and tropical helmet are suitable. For combat the steel helmet is worn. A head net and gloves for protection against mosquitoes are necessary at night and in areas of dense growth. Raincoats are too hot; however, a small poncho of lightweight waterproof fabric is desirable during rainy weather. Shoes should be well oiled to protect them against wet rot.

■ 112. RECONNAISSANCE.—*a.* Reconnaissance is difficult because observation is limited. The thick cover afforded by the jungle, however, permits the close approach of reconnaissance patrols to enemy positions and installations. Troop movements through jungles are generally along trails or roads; hence reconnaissance of such routes is of primary importance. Engineer reconnaissance should include not only existing roads and trails but the location of new routes which may be rapidly opened up or utilized for the movement of combat units. Engineer materials, particularly road materials and timber, must be obtained in the vicinity of the roads. A knowledge of the types and characteristics of local timber and native methods of construction should be secured upon entrance into the area. Many jungle trees which appear to be sound have a pithy center and little structural strength. Others are so hard that they resist the cutting powers of axes and saws. All personnel must therefore be taught to recognize the various trees and their adaptability to engineer use. Road materials consist of native rock, gravel, and timber suitable for corduroy.

b. Reconnaissance patrols should be small, lightly equipped, and composed of highly trained men. Small patrols move rapidly and can avoid enemy outposts. They can approach close to enemy positions without being detected, and can slip through enemy defenses and penetrate into rear areas.

c. Air reconnaissance is of little value in areas covered by jungle. However, aircraft are valuable for reconnaissance to locate broad trails and to locate and check exits from jungle areas and clearings.

■ 113. MARCHES AND CAMPS.—*a. Reconnaissance.*—(1) Route reconnaissance is essential prior to a jungle march. The reconnaissance party should check the time, distance, and trail conditions. The party should carefully check the map and mark on it suitable bivouac areas and water-supply points. In most jungle, troops make almost as rapid progress off the trail as on, and they are much less subject to detection by the enemy. The route requires careful marking. A route reconnaissance should include—

(a) Selection of route.

(b) Description of route, including—

Compass bearings.

Distances.

Landmarks.

Location and description of route markers (blazes, stone markers, etc.).

(c) Check of map.

(d) Suitable bivouac areas.

(e) Water-supply points including locations for drink-water supply, watering animals, and washing and bathing.

(f) Engineer work, including stream crossings, fords, bridges, and trail improvements.

(g) Sources of engineer supply, including location and type of timber suitable for work required, gravel deposits, and rock.

(2) Route reconnaissance is an engineer task. The reconnaissance party should be commanded by an engineer officer and should contain sufficient engineer personnel to perform the mission. Where the situation demands, other troops should be attached.

b. *Streams.*—(1) Streams should receive special attention from the engineer, particularly during the rainy season, as they are subject to flash floods. A ford which is passable when visited by the reconnaissance party may be impassable by the time the troops arrive. During reconnaissance the banks of streams at fords and possible bridge sites

should be examined in order to determine the level of high water. The engineer with the advancing column should anticipate the possibility of flash floods and make sure he has the best possible means of getting the unit across. If a swift stream is not too wide, ropes stretched across the stream permit the column to cross with a minimum of delay. Other expedients should be used according to the situation.

(2) Suitable streams may be utilized as a route of advance and supply. The engineer must plan such use in advance. He must determine if the stream is navigable throughout for boats and rafts, determine the number and types of boats available, and the location of timber or other material suitable for the construction of rafts.

c. Cutting trails.—If a trail must be cut as the column advances, the work is done by either one or three groups. The trail-breaking group, armed with machetes, is composed of men from the column. It works under the direction of an engineer, who should be one of the members of the party which made the initial reconnaissance. It works in relays and cuts and clears only enough vegetation to permit passage of the column. When it is desired to develop the route into a trail, a clearing group follows the column, clearing the trail to the desired width. This group, composed of engineer personnel, is equipped with axes and saws for cutting heavier trees. It is followed by a construction group, also of engineer personnel, which constructs the necessary bridges and improves the trail for use as ordered.

d. Trail maintenance.—Where the trail is to be used for supply and evacuation, the unit engineer plans and executes maintenance until this task is taken over by engineers of a higher echelon. During the rainy season the surface of a trail used by animal transportation rapidly acquires the consistency of thick soup. This condition is disagreeable to men and animals and tires them, but does not make the trail impassable. Where the situation does not warrant utilizing rock, gravel, or corduroy, the best method of improvement consists in periodic relocation of part or all of the trail. The tendency to widen the trail should be avoided.

e. Selection of camp site.—A good camp site should be on high ground, affording natural cover, drainage, and breeze

whenever possible. Picket lines should be placed down wind and as far from the camp as security considerations permit. Sometimes lack of water for cooking, watering animals, and bathing makes lower ground necessary.

f. Occupation of camp.—When practicable, the march should be completed so as to permit all units to go into camp prior to darkness. Only small trees and underbrush are cleared, leaving a canopy overhead for concealment.

■ 114. SECURITY.—*a.* Without exception, every unit in a jungle theater of operations must provide itself with all-around security.

b. Engineer units at work are particularly vulnerable to attack by infiltrating enemy groups. Therefore adequate security measures must be taken at all times. On small jobs where the force is a company or less, the engineer unit commander must furnish his own security. Due to the limited observation afforded in the jungle, a larger proportion of the force will be required on this service than in more open terrain. This must be considered in planning engineer work. For example, on a platoon job not more than two squads should be considered as available for engineer work. Where the requirements of engineer work are great, the unit engineer should request the attachment of infantry to his force to furnish security. This will permit all engineers to be used for engineer work.

■ 115. COMBAT.—*a. General.*—(1) The jungle makes it difficult to maintain centralized control in units larger than a battalion. As a consequence, control is decentralized to small-unit commanders. The maximum in self-reliance, initiative, and aggressiveness is required of squad leaders and other small-unit commanders.

(2) The jungle is the ally of the attacker if he does not bunch up. Due to the heavy cover, small units can advance with secrecy, work their way through the enemy lines or around a flank, and attack the rear of his position. Surprise and demoralization can thus be obtained and should be exploited to the maximum.

(3) The importance of routes of communication for supply and control of large units makes them military objectives of first importance. Consequently, battles will frequently

be fought for the capture or retention of roads or trails. Where the road is approximately parallel to the direction of advance of the attacker, successive delaying positions can readily be flanked, and the defender must plan to combat this.

b. Attack of a river line.—Taking advantage of the cover afforded by the jungle, troops for a river crossing can be brought up with great secrecy. Surprise can thus be obtained if the crossing is made with the greatest speed. Rafts and boats obtained locally are used. Rubber assault boats should be packed forward for the crossing. It will seldom be practicable to bring up heavier equipment for the initial crossing.

c. Defense of a river line.—A river must never be relied on to hold back the enemy. The best position for the main line of resistance and supporting weapons is on the river bank. Due to the advantage in obtaining surprise which the jungle gives the attacker, the enemy side must be thoroughly covered by reconnaissance and security detachments in order that information of impending enemy attack can be obtained at the earliest possible moment. All boats along the river should be moved away from it or destroyed.

d. Raids.—The jungle furnishes excellent cover for raids on the enemy rear-area installations and his line of communication. Engineer demolition parties should be sent out to demolish bridges, ammunition dumps, and other facilities and installations in the enemy rear areas.

■ 116. **WATER TRANSPORTATION.**—Water transportation is the most economical and often the surest means of supply. Streams and all waterways should be used to the fullest extent possible. Supplies transported over water routes are less liable to loss and damage; fragile food containers are safer, and the destruction caused by insects is avoided. Boats, canoes, and rafts are employed at every opportunity. Where practicable, dumps should be established along watercourses to save transportation by overland.

SECTION III

DESERT OPERATIONS

■ 117. **GENERAL.**—FM 31-25 should be studied for more detailed information on desert operations. Desert warfare

is characterized by dependence on water supply. Denial of water facilities to the enemy is sure to bring about a successful conclusion to a campaign. Except for limitations imposed by water, desert terrain allows almost complete freedom of maneuver, because of the absence of natural obstacles. Hence, maneuver and all-around protection are emphasized, and the maximum use of armored fighting vehicles, aviation, and motor transportation is possible. The capture of unfortified terrain other than water-supply points seldom assists in the defeat of the enemy. The two principal objectives generally are the destruction, first of enemy supplies, particularly water and gasoline, and next of his armed forces.

■ 118. Food.—*a.* Normal field and emergency rations are suitable for use in the desert. Cooking is usually done by individuals and small units. Rations should be of a type the individual can prepare and should be so packed that they can be broken down for issue to individuals and small groups.

b. Every vehicle should be equipped with a small cookstove, using gasoline or canned heat as fuel. The use of thirst-producing condiments should be avoided.

■ 119. USE OF WATER.—*a.* The importance of water in desert operations cannot be overemphasized. Troops must be conditioned to live on a limited water ration. All issues of water to individuals should be made by noncommissioned officers upon the order of an officer; no water should be taken from water-supply cans, except under supervision at regular issue periods. For short periods in an emergency, water consumption can be reduced to $\frac{1}{2}$ to $\frac{3}{4}$ gallon per man per day, but this seriously affects the efficiency of the individual.

b. Many of the sources of water supply in the desert furnish water with a relatively high degree of salinity. This as well as the addition of salt will help make up the loss of body salts caused by excessive perspiration. Salt tablets should also be issued for this purpose. Salt water from natural sources must not be used except where the concentration and composition of the salt is known and a medical officer has authorized it. Smoking, particularly during the day, increases the desire for water and must be avoided.

c. Water supply is discussed in section IV, chapter 10.

■ 120. CLOTHING.—*a.* The present authorized clothing, both summer and winter, is suitable for desert operations. Because of the wide temperature range and the cool nights, some sort of woolen garment is needed for wear at night during the hot season. A woolen band should be worn over the stomach, particularly in summer, to prevent stomach chills.

b. Headgear must have provision for air space and a shield for the eyes. The liner of the issue helmet is worn when not in combat; the steel helmet is worn during combat.

c. Special individual equipment which will add to comfort and efficiency includes goggles, respirators, sunglasses, neck cloths, nose cloths, and fly switches.

■ 121. MOTOR TRANSPORTATION.—*a.* While every type of military vehicle, with the exception of motorcycles, can be employed for operations in the desert, modifications are often necessary or advisable. All water-cooled vehicles should be equipped with condensers to prevent waste and reduce consumption of water. Special care must be taken to prevent sand in the air from being drawn into the motor. Air pressure in tires must be varied to suit the ground surface. On sand, the pressure should be reduced to the minimum; on rocky ground the tires must be fully inflated.

b. Each vehicle must carry the equipment necessary to extricate itself from soft sand.

■ 122. DESERT NAVIGATION.—*a.* The almost complete absence of roads, trails, and landmarks in the desert makes it necessary to use special equipment and methods for maintaining direction and locating positions. Maps are of value primarily as charts from which the magnetic bearings for movements are determined. As installations are established in a given area, the locations are plotted by coordinates on the map. The bearings of a desired movement are then determined from the map by means of a protractor. In making short moves when visibility is good, a course may be laid by magnetic compass and odometer. Other methods used over longer distances involve the use of the sun compass and other astronomical instruments.

b. Every officer and noncommissioned officer of a desert force must be able to navigate with magnetic and sun compasses and odometer. Every unit should have one or prefer-

ably two navigators trained and equipped to determine positions by astronomical means.

■ 123. SECURITY.—*a. During daylight.*—Security is provided by adopting a widely dispersed formation during movement and at halts, and by the use of patrols all around. Surprise attack by ground forces is practically impossible if adequate reconnaissance measures are taken. Threat of hostile air attack is always present and antiaircraft lookouts must be posted, antiaircraft weapons manned at all times, and an adequate warning system established. Individual emplacements for protection against air attack are constructed at halts. These can seldom be concealed from air observation but should be widely dispersed so as to offer a poor target.

b. At night.—A close formation should be used for a night bivouac unless there is no chance of a ground attack. Machine guns and other weapons are sited to cover the perimeter of the bivouac, and all-around listening posts and night patrols are organized. Sound carries well at night and listening posts normally provide adequate warning of hostile raids. The operations of security patrols at night require careful coordination with listening posts to prevent the patrols causing false alarms. Patrolling should be intensified before daylight to assure safe movement to a dispersed daylight formation. Rectangular fox holes should be dug for cover against air and ground attack. Security from air attack is provided by light discipline, radio silence, and dispersal.

■ 124. CAMOUFLAGE.—*a.* The lack of natural concealment in the desert places special emphasis on camouflage. Protective painting is used for all vehicles and material. A film of oil or grease should be painted on all vehicles and guns so that the sand and dust will cling to the film, thus giving the object the color and texture of the surrounding terrain. Windshields, except for a narrow rectangle about 2 by 8 inches, and all bright surfaces should be similarly treated. Windshields should be greased or painted both outside and inside. Camouflage nets should be provided for all trucks and weapons put in position. Shadows are the principal sources of information as to the location and nature

of objects, and every effort must be made to conceal or distort them and to reduce them by digging in vehicles, weapons, and tents. Maximum use should be made of broken ground such as dry washes, sand dunes, and other natural features.

b. Deceptive measures are of great importance. Great numbers of dummy installations should be built and realism obtained by overnight changes of location. In forward supply depots and dumps, the nature of articles should be concealed, usually by burying, in order that hostile aircraft cannot concentrate on the more vulnerable supplies, such as fuel and ammunition.

c. It is impossible to conceal tracks, except on rocky ground. To avoid converging tracks, which disclose the location of important installations such as command posts, vehicles must follow designated routes when approaching these localities. They are not permitted to approach closer than 300 or 400 yards to discharge passengers, proceeding then to a dispersal area or to concealed vehicle dugouts. The location of mine fields is often disclosed by the abrupt turns which vehicles have made to avoid the field. Proper control of such tracks may be used to deceive enemy air observers.

■ 125. SUPPLY.—a. In the desert, supply is the primary limiting factor in operations. There are, except for some water, no local sources of supply. It is normally handled by trucks and air transport.

b. It is impossible to conceal the location of supply installations of any size. Protection is gained by dispersion of all supplies over a large area and concealment of the nature of supplies by covering them. Mine fields are used around all forward supply depots.

■ 126. ENGINEER TASKS.—a. The principal engineer tasks in desert operations are reconnaissance; construction and removal of antitank obstacles, particularly mine fields; supply and transportation of water; destruction of water supplies and disabled enemy vehicles; rapid road construction; construction and camouflage of fortifications; and the establishment of transport and port facilities.

b. The laying of mine fields is one of the most important

tasks of the combat engineers. Upon entering any theater of operations the adaptability of mines to types of soil found there is carefully tested and the proper method of burial found. Mines with spider tops must be placed with special care in order that the loose soil does not get under the spider and render the mine inoperative. Where a surface crust exists, camouflage of the mines will be difficult. With careful training, mine fields can be rapidly laid and removed by combat engineers. Because there are so few landmarks, accurate recording of mine fields is difficult and should receive special attention. Combat engineers are specially trained in enemy mine-field technique and are prepared to breach enemy fields and remove them. Familiarity with enemy mines permits their use in our own fields. For the purpose of quickly breaching enemy mine fields, engineer troops should be placed well forward.

c. Engineers are responsible for the development of water courses, manufacture of potable water, transportation of water from water-supply points to water-distributing points, and issue of water to troops. The first three phases are normally assigned to water supply battalions and the fourth to combat engineers who issue water to the command of which they are a part. Due to the scarcity of water sources in the desert, water-supply troops must be specially equipped to develop all possible sources. Transportation of water from water-supply points to water-distributing points will usually involve long hauls. In planning water-supply operations, plans must be based on furnishing the amount of water required to maintain the troops at top fighting efficiency. An adequate reserve of water and transportation facilities must be maintained to insure this supply despite all foreseen types of enemy action. The necessity for dispersion requires the use of many water-distributing points. Destruction of water supplies in a withdrawal may impose heavier delays on a hostile advance than any system of obstacles, and engineer troops must be prepared to execute such destruction by explosives, contaminating the water, or other means.

d. In order to prevent the enemy recovering and restoring for later use any tanks that have been disabled, engineers should accompany or follow closely an armored attack to destroy such disabled vehicles as must be abandoned on the

field. Captured enemy vehicles should be destroyed, unless a guard sufficiently strong to prevent their recapture is placed over them.

e. The supply of camouflage materials and construction of special camouflage installations such as dummy airdromes may often be an engineer task of considerable magnitude. Where extensive use is made of dummy positions, requirements for camouflage materials will be great.

SECTION IV

MOUNTAIN OPERATIONS

■ 127. GENERAL.—a. Mountain operations are greatly restricted by terrain and climatic factors. However, the same combat principles apply to mountain warfare as to other types. The main hindrances are:

(1) Existence of deep valleys, massive ridges, and steep escarpments.

(2) Effect of altitude on personnel.

(3) Liability that snow, rain, fog, sleet, and cold weather will hinder operations.

(4) The fact that mountainous regions are sparsely populated and hence not well developed.

b. Characteristic mountainous terrain with well-defined valley and ridge formations ordinarily limits troop movements to the valleys. Therefore, a terrain corridor in mountainous areas is generally a valley which has roads, railroads, and villages. Here relatively large numbers of troops with full equipment may be employed. Valley operations present no special difficulties to the engineer unless the valley is so narrow as to constitute a defile.

c. Operations in the mountains adjacent to the valley, however, are more difficult and must be conducted by small, specially trained groups of mountain troops. These operations are known as "high altitude" or "high mountain" warfare. The final result of the main operations may be hastened, slowed, or momentarily blocked by the actions of these detachments working in the high mountains. Engineers are present in these groups to block passes or start avalanches and to facilitate movement of heavier loads.

d. Low atmospheric pressure and lessened oxygen supply

at altitudes above 6,000 feet frequently cause mountain sickness (anoxaemia) which severely affects troop performance. Human habitations are not found above 16,000 feet, at which elevation atmospheric pressure is one-half that of sea level. Troop operations at such extreme altitudes will be very limited.

e. Snow, rain, fog, sleet, and cold weather often hinder mountain operations. Whether or not snow and cold will be encountered in a given mountainous area depends on the elevation, geographical location, season, proximity to ocean and other factors. Perpetual snow is found at sea level in the polar regions, at 10,000 feet elevation at latitude 40°, and at about 17,000 feet at the equator. Seasonal and local variations alter these limits somewhat. A temperature drop of 3° F. can be expected for each 1,000 foot rise in elevation. In the mountainous regions where snow and extreme cold are encountered the principles of section I and of FM 31-15 are applicable.

f. Most mountainous regions do not lend themselves to commercial development. Roads are few and local engineering resources and facilities limited. Beyond the valleys, movement is limited to trails. In some mountainous regions, such as interior New Guinea or the northwestern Indian frontier, the entire area is semicivilized and completely lacking in engineering facilities.

■ 128. CARE OF MEN.—*a.* Men selected for mountain units should preferably have knowledge of mountain climbing and be able to use skis and snowshoes. They should have sound hearts and lungs and should not be subject to mountain sickness or giddiness in high places.

b. Care of the men so selected involves provision of proper equipment, clothing, food, and housing. Special equipment should include the following:

White snow hoods.

Snowshoes (for all troops).

Skis (for one-third of troops).

Sun glasses.

Alpine line.

Climbing rope (strong manila cord).

Ice creepers (crampons).

Ice ax (stout stick as long as from elbow to ground, with adzelike blade and spike at one end and long spike at other end).

c. Clothing should be as near windproof and wetproof as possible. The most important item is shoes. The best all-round shoe for mountain work is a heavy, specially nailed, high shoe made of leather. For operations where secrecy is essential, a boot of the Maine hunting type is best. This boot has a heavy, studded rubber sole and a leather upper extending halfway to the knee. A full rubber boot should never be worn.

d. For large units operating in lower sections of the mountain area, the ordinary ration will be sufficient. Troops operating in the higher altitudes (10,000 to 13,000 feet) will need to pay particular attention to diet.

e. Housing of mountain troops depends upon climatic conditions and prevalence of wooded areas. In timbered areas, lean-tos or cabins can be constructed. Above the timber line, troops must build their own ice igloos or find suitable sleeping places in rock, ice, or snow caves. (See FM 31-15.) Troops should carry sleeping bags (waterproof type). A pack of the board type is much better for mountain troops than the usual rolled pack.

■ 129. TRANSPORTATION.—a. Motor transport is of great value in mountainous countries when it can be used. However, pack trains must be used in many otherwise inaccessible areas. Depots supplied by motor transport are pushed as far as possible up the valleys and trails. Any available railways, cableways, and air transport should be used to fullest capacity.

b. Many lines of communication in mountains are narrow paths where the only suitable transport is the pack animal. Mobility is the outstanding advantage of this type of transport, which can follow wherever troops go. Disadvantages include the low carrying capacity per animal (about 200 pounds) and the length of the column. Also, a pack column cannot serve a transport line longer than 3 days' march, due to the amount of forage necessary.

■ 130. RECONNAISSANCE, MARCHES, AND CAMPS.—a. Judging terrain and choosing the best available routes are among the

most important duties of engineers in the mountains. An engineer should be trained to look at a range of mountains and find the easiest route across it with the aid of a map. Reconnaissance of a route is simple up to the point where the climb starts, if the route is marked on the map. It becomes more difficult after the mountain ascent has begun over unmapped paths and animal tracks, which are difficult to follow. Finally areas may have to be crossed which have no paths at all, such as steep valleys, depressions, cliffs, and glaciers.

b. In marching, it is advisable to dress lightly. Pack but do not wear extra clothing. An unhurried step is best. On steep slopes take short paces. Rhythm and deep breathing are the secrets of easy climbing.

c. It is theoretically safer in mountains to march along ridges than in valleys. For any but small units, marching along ridges is generally impossible, except when the ridge is a broad plateau. Therefore, it is usually necessary to advance along the roads of the valley, while patrols or detachments occupy the successive peaks or heights that dominate the route of advance. Frequently, however, dominating heights in the mountains do not actually permit fire to be delivered along the route of approach and hence need not be occupied.

d. Any force in the mountains in proximity to the enemy must be surrounded by reconnaissance and security detachments occupying dominating positions. As a rule, advance guards or covering detachments must be stronger than in ordinary country, as they may have to rely longer on their own forces in combat, owing to their greater isolation and increased difficulties of communication. Generally, they must be at a greater distance from the force they cover. Due consideration must be given to flank guards moving on a terrain more difficult than that of the main column, and the speed of the columns must be adjusted.

e. When starting a march, sufficient time must be allowed to permit security detachments to reach their positions. In cases where difficult terrain makes it impossible for the flank guard to continue covering the main force by parallel marching, fixed flank guards may be sent out in advance to occupy and hold important points until the main column has passed.

f. In the mountains the advance guard must always be one ridge in advance of the main force in order to prevent the latter from being subjected to enemy fire. Before the main force descends into a valley, the opposite ridge must be occupied by the advance guard. A force with machine guns should also be left on the ridge vacated. They remain until the following ridge is occupied.

g. Mountain war is often a race to occupy important points, such as ridges and passes, before the enemy can do so. A difference of a quarter of an hour in placing a machine gun on a height may decide the result of the day. In planning a march, it should be remembered that usually the basis of estimation should be the number of feet of altitude climbed or descended, and not the horizontal distance covered. It may be estimated that a force can climb about 900 feet per hour and descend 1,200 feet per hour. In winter and in snow these figures will not be reached. When marching in snow, the men at the head of the column breaking the way must be frequently changed, since this is extremely tiring. In mountains, forced marches are made, not by increasing the speed of the march, but by reducing the length of the halts.

h. At halts for the night, security forces are posted on all sides to hold all commanding ground within rifle range. The camp should be so located as to be protected both from sniping and surprise assault.

■ 131. **EQUIPMENT.**—As much of normal construction equipment of the combat engineer battalion should be taken into the mountains as transportation facilities permit. The present engineer tool sets and heavy equipment are well adapted to mountain work. Air compressors lose efficiency as the altitude increases.

■ 132. **SUPPLIES.**—Because transportation is difficult, only limited amounts of engineer supplies can be carried into the mountains for operations by detached groups. The difficulties of loading bulky equipment on pack animals and the need for increased amounts of special equipment, such as block and tackle, further limit the amount of available transport space for supplies. The most essential supplies will be explosives and these must be expended with great

care. Approximately double the normal allowance of explosives and supplies should be carried.

■ 133. CONDUCT OF OPERATIONS.—*a.* The conditions of mountain warfare require that mountain engineers be prepared to—

(1) Send out numerous small work parties on specific missions. Such parties should have good cross-country mobility and should carry their own tools, supplies, arms, and food. They should be able to operate independently for at least 3 days, and longer, if necessary.

(2) Accomplish extensive drilling and blasting in rock for purposes of creating road blocks, excavating for field fortification, opening new roads and trails, or repairing enemy road blocks and demolitions.

(3) Build bridges at sites which do not permit the use of intermediate supports.

(4) Make extensive use of antipersonnel and other mines.

b. Possibly the most extensive use of mountain engineers will be in connection with obstacles. Even minor demolitions may often be of great value. Interruption of paths at the crossing of fissures and brooks may cause considerable delay to the enemy because of the difficulty of coaxing pack animals through minor obstructions. Shelters in mountain areas are so scarce that destruction to deny their use by the enemy is a more profitable employment of engineer troops than on level terrain. Well planned demolitions at tunnels, bridges, and sidehill cuts on roads or railroads may require several days or even weeks for reconstruction. Antipersonnel and other mines may be profitably employed, because they can be well concealed in mountain country and hence may not have to be covered by fire.

c. In mountain combat operations, particularly if extensive, a great amount of engineer work is necessary on roads and means of communication. Since there is little local industrial equipment and trained personnel, such work will be carried out by Army personnel alone. Normally in mountain campaigns a large percentage of the total force is engaged in such work—sometimes as high as 25 percent.

d. Engineers may also assist in the lay-out of defensive positions. As regards the traces of a defensive position

across a valley, it is best to place the flanks of such a position ahead of the center in order to obtain flanking fire from one side of the valley to the other. In selecting defensive positions, it is best to avoid those allowing protected avenues of approach to the enemy. The ones selected should have good fields of fire. Trenches and machine-gun nests require a long time to excavate in rock. Once established, however, such positions are very strong. When time is limited, built-up parapets of stone or loose wire entanglements may be used.

e. In offensive operations it should be remembered that high ground has advantages for the defense. Frontal attacks on elevated enemy tactical localities should therefore be avoided and flanking action made habitual. There is often a question as to which terrain is the more vital—heights or lowlands. Theoretically, heights afford good points of vantage and possibilities of flanking fire, but often these advantages disappear due to the lack of visibility. Wide valleys with roads and cover are ideal avenues of approach, but narrow valleys without cover may be death traps. Mountain passes, bridges, and other defiles are always important objectives.

CHAPTER 7

DENIAL OPERATIONS AND LAY-OUT AND CONSTRUCTION OF DEFENSIVE POSITIONS

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SECTION I

DENIAL OPERATIONS

■ 134. GENERAL.—*a.* A *denial operation* denies the enemy, by removal or destruction, things that otherwise would be captured and utilized. It is a responsibility of all commanders. For commanders having area jurisdiction the responsibility for denial includes everything in the area; for other commanders, unless specifically ordered otherwise, it includes only the material and supplies assigned their units.

b. A *scorched-earth* policy makes an entire area useless to the enemy by the removal or destruction of everything that can in any way aid him. It is denial carried to the extreme. The civilian population of an area in which the scorched-earth policy is to be applied must be evacuated if the area is friendly. Such evacuation must be strictly controlled to prevent interference with troop movements. A partial denial operation, less drastic than a scorched-earth policy, is more often employed.

c. The decision as to the extent to which denial operations are to include nonmilitary supplies and facilities is a responsibility of the highest military commander in the theater. When the denial policy is established, the detailed planning and execution involve major engineer and logistical problems.

■ 135. PERSONNEL EXECUTING DENIAL PLANS.—Military authorities prepare denial plans and execute them. The destruction or removal of military supplies and equipment is done by the troops to which they pertain. In a friendly country, civilians normally are used in the preparation and

execution of the denial plan for civil installations. They work under military personnel while preparing these plans, carrying on preliminary work such as placing explosive charges and executing the plans. In unfriendly territory, military personnel execute the operations necessary for denial of both military and civilian supplies, equipment, and installations. This is generally a large task, requiring a high degree of technical skill and considerable time for detailed planning, careful preparation, and execution. Engineer troops are especially suitable for executing denial operations, but troops of other arms and services are also used extensively. It is a command decision to determine when preliminary work is to be effected and when plans are to be executed. A denial operation to be successful must be prosecuted ruthlessly.

■ 136. ITEMS DENIED ENEMY.—The following items should be considered in the preparation of the denial plan:

- a. Military equipment and installations.
- b. Military supplies.
- c. Communication.
 - (1) Railroads and rolling stock.
 - (2) Highways.
 - (3) Canals.
 - (4) Airports.
 - (5) Bridges.
 - (6) Signal communication.
- (a) Radio.
- (b) Telephone.
- (c) Telegraph.
- d. Utilities.
 - (1) Electric power plants and distribution systems.
 - (2) Gas systems.
 - (3) Water systems.
 - (4) Sewer systems.
- e. Industrial plants, with their equipment and supplies.
- f. Fuels.
 - (1) Oil and oil products.
 - (2) Coal.
 - (3) Wood.

- g.* Food, including livestock.
- h.* Raw materials, including their sources, such as mine installations and oil wells.
- i.* Ships and harbor facilities, especially docks, bunkers, and ship-repair points.
- j.* Buildings and structures.
- k.* Locks and dams.
- l.* Motor transportation.

■ 137. DENIAL BY REMOVAL.—Evacuation of matériel is as much a part of any denial operation as destruction. Because large quantities of industrial equipment and supplies cannot be moved during active operations, evacuation must be started early and conducted in accordance with prepared priority lists. Skilled workers and operators of machinery, such as toolmakers and welders, are evacuated with the machinery they operate. Evacuation of all inhabitants from the area is desirable, but in densely populated sections this may not be practicable.

■ 138. DENIAL BY DESTRUCTION.—*a.* All possible methods of destruction are used. The most common are:

- (1) Fire.
- (2) Water—flooding land or drenching products.
- (3) Mechanical methods, such as breaking with a sledge hammer or cutting with oxyacetylene torch.
- (4) Explosives. (See FM 5-25.)
- (5) Contamination.
- (6) Projectiles—small arms, artillery, and bombs.

b. In order that destruction may be executed at the desired time, personnel to destroy each item must be designated in advance, supplies necessary for the destruction must be estimated and assembled at convenient locations, the circumstances under which the destruction is to take place must be definitely prescribed and, if orders for destruction are to be issued, the means of transmission must be provided. Permissible types of orders governing execution of demolitions are given in paragraph 232c and may be applied to any other type of destruction.

SECTION II

LAY-OUT AND CONSTRUCTION OF DEFENSIVE POSITIONS

■ 139. GENERAL.—*a.* This section describes the nature and extent of engineer activities in connection with the lay-out and construction of defensive positions and the supply of fortification materials.

b. In general, defensive positions are laid out and constructed by the troops which are to occupy them. However, engineers frequently assist in the organization of a position by providing engineer tools and materials and engineer technical advice and assistance. Especially in a deliberate defense, technical problems of drainage, clearing, camouflage, excavation, and construction of defensive works may call for extensive use of engineers. In some cases a defensive position may be laid out and partially constructed by engineers and other troops in the absence of the troops who are to defend it.

■ 140. LAY-OUT OF POSITION.—When infantry units make contact with the enemy and take up the defensive, or when they occupy a position where no preparatory work has been done, they normally lay out the position without engineer assistance. In other cases, however, engineers may be called upon to assist.

a. Hasty defense.—(1) When a position is to be occupied by infantry units hurriedly or under cover of darkness, it is essential that at least the main line of resistance and principal limiting points be marked on the ground in daylight in such manner as to render them easily identifiable at night. Guides are trained to direct the night movement of the occupying units from the rendezvous points to their defensive positions. In many cases, infantry mark the position on the ground and furnish their own guides, but at times, and especially in a withdrawal, engineer troops are employed for this purpose.

(2) The general location of the main line of resistance, the regimental reserve line, and the principal limiting points are specified by higher commanders. The exact locations are

determined after careful study on the ground in daylight by the officers who make the lay-out. Observation, fields of fire, concealment, communication, and obstacles afforded by the terrain are all carefully considered. A more detailed lay-out of the position, including company boundaries, platoon defense areas, and approximate positions of infantry heavy weapons, is marked on the ground by engineers, if desired by the infantry commander concerned and if sufficient engineer troops are available. When practicable, the detailed lay-out should be prescribed by the infantry commander or his representative at the site and marked on the ground by engineer troops. When an engineer commander makes the detailed lay-out, he must have complete knowledge of the characteristics and firing positions of infantry weapons, effects of terrain, organization of infantry, characteristics of various standard types of field fortifications, and principles of organization of the ground as given in FM 5-15.

b. Deliberate defense.—(1) When an infantry unit organizes deliberately a position which it is to defend, the position is laid out with little or no engineer assistance. Engineers, however, if requested, furnish marking materials and advice with regard to obstacle technique, drainage, and camouflage.

(2) In many cases a defensive position is laid out and partially constructed prior to assignment to any particular unit. Reserve battle positions, switch positions, and defense areas for protection of coast lines are frequently so prepared. In such a case, the unit engineer is normally charged with laying out and marking the position in accordance with directives issued by the unit commander. In the lay-out, the unit engineer should be assisted by specialists on infantry and artillery weapons. When practicable, the completed plan should be submitted to the unit commander for approval before construction work is started.

■ 141. CONSTRUCTION OF FORTIFICATIONS.—Field fortifications are normally constructed by the troops which are to use them. The unit commander specifies the type of fortifications to be used and priorities of construction. The unit engineer advises the commander on these points when considerations of camouflage, supply of engineer materials, and employment of engineer troops are involved. When fortifications are con-

structed by personnel other than the troops which are to defend them, all construction work normally is executed under engineer supervision. Labor employed may include general engineer units of all types, units of other arms and services, and civilian labor.

a. Types and priorities.—(1) In organizing positions deliberately, the construction should be such as to withhold from the enemy information as to the location of principal defensive elements. Communication trenches are limited to areas where they can be concealed by trees or special camouflage measures, or decoy trenches are constructed on such an extensive scale that the enemy will be deceived as to the exact location of the important defensive works. Weapons emplacements and troop shelters are of types which best fit the means available and the terrain, and which afford as complete protection as the time, troops, and materials available permit. For prescribed types of fortifications see FM 5-15.

(2) Priority of construction should provide for efficient use of available time, personnel, tools, and materials. It should insure that maximum value is derived from the time and labor already expended, if the position is attacked prior to completion of construction work. Camouflage and preparation of decoys must proceed concurrently with other work. In organizing positions deliberately, any features of construction which can be carried on after contact with the enemy or that might give away the position are deferred until other work is completed. For suggested priorities of construction work see FM 101-10.

b. Employment of units for construction work.—(1) *Infantry assigned to defend.*—Construction work executed by infantry units which are to defend the position proceeds under infantry commanders. Engineer troops furnishing assistance to infantry usually are employed under the control of the unit engineer and execute special tasks for which engineer training and special equipment are required. In some cases, such as the hasty organization of an outpost position, it may be necessary to attach engineer units furnishing assistance. The engineers so attached should be employed as a unit by the infantry commander on tasks especially suitable for them; they should not be subdivided

into small elements and distributed to assist in the execution of general tasks on which infantry units are being employed.

(2) *Other units.*—In cases where construction of field fortifications is executed by units other than those which are to defend them, the work customarily is carried out under the unit engineer. Initial plans for the position, including lay-out, types of construction, and priorities for construction, are prepared and submitted to the unit commander for approval. The work to be done is then subdivided among the units to be employed, and frequent inspections are made to insure its execution in accordance with the approved plans.

(a) General engineer units are assigned sectors of the defensive position and are made responsible for all construction in them. Some installations, such as reinforced-concrete structures, may be excepted from this area assignment and made the responsibility of specially trained and equipped engineer units or civilian organizations.

(b) Troop units other than engineers are given area assignments similar to those of engineer units. They execute the work under their own commanders, but some engineer personnel is assigned the commander of each large unit to assist him in technical supervision and inspections. Features of construction work requiring special skill and equipment are exempted from the responsibility of the troop commander and assigned to special units.

(c) Where civilians are employed in large numbers on fortification work, preferably they should operate under civilian foremen and be given area assignments similar to those of troop units. Some engineer personnel is required to supervise their work. The degree of supervision varies with the loyalty and skill of the personnel employed.

(d) The engineer headquarters assigned to each area or task renders progress reports at frequent intervals to the engineer responsible for the construction work.

■ 142. SUPPLY OF TOOLS AND MATERIALS.—The amount of materials required for field fortifications is normally so great that it cannot be transported by engineer vehicles alone. The additional transportation required is furnished from other troop units employed on the work and, upon orders of the unit commander, from quartermaster truck units.

Principal materials supplied include sandbags; materials for barbed-wire fences; timber for revetment, trench boards, and shelters; chicken wire for revetment; elephant-iron for shelters; nets and garnishing materials for camouflage; and steel bars, cement, and aggregate for concrete shelters and emplacements. Quantities of materials can be estimated by using data given in FM 5-15 and 5-35. Methods of distribution are given below.

a. Hasty defense.—(1) *Tools.*—Tools for executing fortification work are no longer carried by the engineer combat battalion. The infantry carries its own entrenching sets.

(2) *Materials.*—(a) When contact may be made before the hasty organization is completed, distributing points for fortification materials should be located far enough to the rear so that enemy infantry fire in front of the main line of resistance cannot prevent their use. They should be close enough to the line of contact to reduce to a minimum transportation problems. In most cases locations near the regimental reserve line are best. Some materials may be dumped forward of the designated distributing points, but in such cases these dumps should include only materials which can be completely utilized in a short time. It is desirable to provide a distributing point for each front-line infantry battalion. Distributing points should be on good roads, have defilade and, whenever possible, concealment from aerial observation. Materials are usually supplied without formality on the statement of the receiver that they are needed.

(b) In addition to those provided for the main battle position, one or more distributing points may be provided for fortification materials to be used on the flanks or on defensive localities behind the battle position. These distributing points should be well to the rear, in concealed locations accessible to trucks at all times.

(c) Engineer distributing points are designated by the unit commander in orders; their number and locations are based on the recommendations of the unit engineer.

(d) Engineer distributing points for fortification materials are manned if special measures for providing access to them are necessary. If not, the material may be dumped in an infantry area, the infantry commander notified of its

location and told to supervise its distribution. The unit engineer must decide in each case whether or not the distributing point needs manning by engineer personnel.

b. Deliberate defense.—In deliberate defense the supply of engineer materials for fortification work can be planned and regulated more carefully than in hasty defense. Special tools and heavy equipment are obtained from depots in the army service area and communications zone. Fortification materials are brought up and dumped on the position only as needed. In order to insure economical use and distribution of materials, a simple system of property accounting is set up. Trucks bringing up material are routed through a distributing point which acts as a dispatching station, and the loads of trucks are delivered at or close to the place where the materials are to be used. Truck movements are confined to previously planned and prepared trails in order to avoid unnecessary tracking.

CHAPTER 8

TROOP MOVEMENTS, SHELTERS, AND CAMPS

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SECTION I

TROOP MOVEMENTS OF ENGINEER UNITS

■ 143. **GENERAL.**—A successful troop movement places troops and equipment at their destination at the proper time and in condition for effective work. Careful planning, preparation, and execution are required. For general information on this subject, see FM 100-5 and 25-10.

■ 144. **DEFINITIONS.**—*a. Entrucking point (EP), or detrucking point (DP).*—An easily recognizable location where the head of a motor column or element of it halts for loading or unloading.

b. Initial point (IP).—An easily recognizable point at which a column or element of it is formed as its various subdivisions arrive.

c. Entraining or detraining point.—Railroad station or yard at which troops are entrained or detrained.

d. March unit.—A tactical unit under a single commander for the purposes of march control. A company, troop, or similar organization normally forms the march unit.

e. Regulating point (RP).—An easily recognizable location where an incoming motor column or element of it is separated into groups for movement to assembly or bivouac areas, or to entrucking or detrucking points.

f. Serial.—One or more march units preferably with the same march characteristics, placed under a single commander for march purposes.

g. Shuttling.—A method of moving troops and matériel by repeated trips of the same motor vehicles.

■ 145. METHOD.—*a.* Troop movements may be made on foot, by truck, rail, water, air, or by any combination of these methods.

b. All movements in the combat zone and short movements in the rear of that zone are generally made on foot or by truck. Whenever practicable, trucks should be used to increase mobility and reduce fatigue of troops.

c. Movements of more than 150 miles in areas reasonably free from hostile air attack are generally by rail.

d. When an adequate land route exists, movements by land are usually preferable to movements by water.

e. Air transportation is used to move troops when time is the primary consideration, when the destination is inaccessible to other means of transport, or when troops are to be landed in hostile territory.

■ 146. RECONNAISSANCE.—To permit proper decisions as to the route of march, hour of departure, disposition of troops, means of transportation, and preparations, reconnaissance is necessary. (See chs. 3 and 11, and FM 100-5.)

■ 147. SECURITY.—*a. Ground.*—Engineer troops moving in rear areas mainly need security against air attack. When the threat exists, measures must also be taken to prevent surprise by enemy armored groups. Engineers moving in proximity to the enemy furnish their own ground security unless it is specifically provided for them, such as when they are part of a larger force. (See ch. 5.)

b. Air.—Engineers always furnish their own security against air attack. Measures to insure secrecy during a movement are directed primarily against aerial observation. These include marching at night instead of in daylight, forbidding the use of lights, and observance of camouflage discipline in bivouac and during halts.

■ 148. ORDERS FROM HIGHER COMMANDER.—*a.* An engineer unit normally moves either independently or as a part of a large unit. An example of the first case would be a corps combat battalion moving to a new work site on orders of the corps engineer and of the second, a combat battalion accompanying its division. In both instances the engineer commander

receives orders for the move from the unit commander. These orders cover such details as—

- (1) Kind of movement.
- (2) Time of starting.
- (3) Destination, or duration of move.
- (4) Route.
- (5) Location of IP or EP and route thereto.
- (6) Missions en route.
- (7) Instructions for engineer troops to be attached to other elements of the command.
- (8) Precautions as to secrecy and security.
- (9) Instructions for detachments left behind.
- (10) Instructions for trains, supply, and evacuation.
- (11) Other details requiring coordination by the higher commander.

b. When the commander of a large engineer serial desires to move it on his own initiative, he requests authority of his commander in order to prevent interference with movements of other units.

■ 149. ENGINEER DECISIONS AND ORDERS.—Basing his decisions on orders received and information gained from reconnaissance, the engineer commander prepares, in the general form of a field order, a detailed plan for the march. Normally the march order should be preceded with a warning order so that subordinate units can make advance preparations.

■ 150. PREPARATIONS.—a. In preparing for the movement, allowance must be made for the time required for disposition of extra engineer equipment. Engineer units may have in their possession equipment or supplies issued for special work, which should not be taken to their new location. Prior to departure, arrangements must be made to turn this new matériel over to other troops or to depots. Detachments from depot companies may be used to take over supplies.

b. Administrative preparations should insure that—

- (1) Men, equipment, and motor vehicles are in best possible condition.
- (2) Units are properly equipped.
- (3) Vehicles are properly loaded and serviced.
- (4) Replenishment of supplies is provided for.

(5) Traffic-control arrangements are complete.

(6) Provision is made for care and evacuation of sick and wounded.

(7) New bivouac area has been reconnoitered and plans have been made for its occupancy, including a clearance from staff for use of area.

■ **151. MARCHES BY FOOT.—a. General.**—(1) Movements of foot troops normally include movement of their organic transportation. This transportation should be used whenever practicable to lighten the load on the individual by carrying as much of his personal equipment as the tactical situation and road capacity permit.

(2) Arrangements should be made so the organic and attached motor transportation of a unit moving on foot can travel at their normal road speed. To accomplish this, motor transportation may precede the foot troops to the destination, follow them at such an interval as to arrive at the destination with or soon after the foot troops, accompany them to some extent by moving by bounds, or move by a route other than that used by the foot troops. It is frequently desirable to divide motor transportation into two or more serials. In any case, motor movements should be planned to facilitate the march of foot troops and to assist the unit in executing assigned missions.

b. Orders.—The order for a march should cover as many of the following points as apply. They are listed below in the sequence followed in a five-paragraph field order:

(1) Information of enemy and own troops.

(2) Object of march, time of starting, route or routes, and destination.

(3) Detailed instructions for—

(a) Each march serial, to include such points as—

1. Location of, route to, and time of clearing IP.

2. Route of march.

3. March formation and rate of march to be used.

4. Position in march column and intervals to be maintained.

5. Missions en route.

6. Liaison.

7. Equipment to be carried.

(b) Subordinate units to be attached to other commands, to include such points as—

1. Liaison to be established prior to attachment.
2. Time and place to report for attachment.
3. Missions while attached.
4. Supplies and equipment to be taken.
5. Duration of attachment.

(c) Precautions as to secrecy, security, and march discipline applicable to command as a whole.

(4) Detailed instructions for supply and evacuation, including arrangements for—

(a) Supply of engineer materials needed to accomplish missions en route.

(b) Evacuation of casualties occurring during march.

(5) Detailed instructions providing for maintenance of signal communications, including—

(a) Location of commander, or place where messages will be sent in the march column.

(b) Location and time of opening of any temporary command post to be established during march.

c. Conduct of march.—(1) In starting the march, the commander assembles his subordinate units in appropriate formation and moves them to the initial point in time to avoid delaying other elements of the march column, yet without obliging his command to wait unnecessarily at the initial point or elsewhere.

(2) On the march, rest halts are usually made during the last part of each hour, amounting to 15 minutes the first hour and 10 minutes thereafter. At these halts, men should get off their feet, loosen their packs, and rest.

(3) Troops should drink all the water they need before starting and drink sparingly during the march. Water should come only from sources found safe by the medical service.

(4) The head of each march unit should maintain a steady, even pace at all times to prevent crowding or lagging.

(5) The engineer commander and his staff ordinarily march at the head of the main body of engineer troops.

(6) Stragglers are either admitted to an ambulance by authority of the unit surgeon or are taken in charge by a small guard marching at the tail of the unit.

(7) Troops are not kept in column or under arms any longer than necessary, particularly during rest halts and on arrival at their destination.

(8) Care should be taken that troops are given food and drink of such a nature that it will not reduce their marching ability.

■ 152. MARCHES BY TRUCK (see FM 25-10).—*a. General.*—(1) *Sources of trucks.*—The two major sources of trucks for moving troops are:

(a) Vehicles of organization concerned. As some engineer units do not have transportation for all equipment and personnel at one time, movements depending on organic transportation only may involve shuttling. At times, some organic transportation will be assigned missions elsewhere, so that all units must be prepared to shuttle.

(b) Vehicles assigned by higher headquarters. These may consist of quartermaster motor units of division, corps, or army engineer dump-truck companies; or of borrowed organic transportation from other units.

(2) *Plans.*—In planning a movement by truck, the following points should be considered:

(a) Troops, equipment, and supplies to be moved.

(b) Transportation available.

(c) Distance or duration of movement.

(d) Routes available.

(3) *Location of trucks.*—A single engineer unit, whether moving independently or as part of a command, normally needs only one entrucking point and an initial point. When engineers move in vehicles other than those organically assigned, and several units or parts of units are included in one movement, the plan for loading should provide—

(a) A regulating point, where an incoming truck column is divided into groups, one for each trucking point.

(b) Entrucking points, to which groups of trucks go from the regulating point for loading.

(c) An initial point to which groups of loaded trucks go to be re-formed into one column.

(4) *Organization of movement.*—(a) Routes from RP to IP should be such that trucks do not have to turn around on a road or double back on incoming columns. If possible,

routes from RP to EP's and from EP's to IP should be chosen so that if a steep grade must be passed it may be climbed when the trucks are empty. Trucks should avoid passing through bivouac areas of troops not engaged in the movement.

(b) Guides meet the incoming truck columns at the RP and conduct trucks of each group to designated EP's. Each truck group usually halts at the RP for a short time to receive orders and pick up guides. After entrucking is completed, guides conduct truck groups to the IP.

(c) Trucks normally use the halt at the EP for inspection and servicing, for which 30 minutes ordinarily is allotted. The work of loading personnel and matériel is done concurrently. The latter is begun upon arrival of the trucks, but loading of troops should be timed so there is only a few minutes' wait before the trucks move out. Fifteen minutes is ample time for loading troops with their individual equipment; 6 minutes is enough for trained troops.

(d) On arrival at the EP, troops should be divided into groups of the proper size for truck loads and placed along the road so that each group will be near its truck. This should be done without interfering with other traffic on the road, and without exposing the troops unnecessarily to air attack.

(e) When the truck column nears its destination it passes through an RP where it is separated into groups for movement to DP's. The departure of the trucks from the DP's is coordinated by designation of an IP for continuation of the movement of the truck unit.

(f) After detrucking, troops and matériel should be kept clear of the road until the empty trucks have cleared the DP and following columns have passed.

(5) *Shuttling.*—(a) Shuttling may be done in two ways: by having trucks make complete trips, keeping all entrucking points in the vicinity of the initial bivouac or assembly area; or by having trucks make partial trips after their first one, the troops marching to advanced entrucking points while trucks are moving initial loads. Ordinarily the first method is preferable; the second method should be used only when time is of paramount importance. Careful and detailed planning is essential.

(b) For an engineer unit moving independently by shuttling in a rear protected area, the simplest procedure is first to move all vehicles to the destination with their organic cargoes; then to send back empty such vehicles as are needed to transport the foot troops. For an engineer unit accompanying a large command moving by shuttling, details of the move are prescribed by the higher commander.

b. Orders (see FM 25-10).—The order for a movement by truck is similar in form and in general contents to the march order described in paragraph 151b, but the initial points must also be given in the third paragraph, and similar data pertaining to a truck movement, as covered above, should be added. When shutting involves marching, orders should also cover instructions for troops marching from the initial area to advanced EP's.

c. Conduct of truck movement.—(1) When tactical considerations permit, truck columns may move at prescribed average rates of speed. The minimum distance between trucks varies almost directly with the speed, and thus the time length of a column is about the same for all normal speeds. The rate of speed prescribed depends on the type and condition of road, weather, and other factors. A long column, as for a regiment, operates most efficiently at speeds from 25 to 35 miles per hour on good roads, and from about 15 to 25 miles per hour on poor roads.

(2) A 15-minute halt is usually made at the end of the first hour to inspect trucks and loads and to permit men to relieve themselves; similar halts are made every 2 or 3 hours thereafter. Normally, the vehicles of a column do not close up for such halts but halt simultaneously at a predetermined time.

(3) Any truck forced to stop should move off the road. If unable to clear the road under its own power, it should be pushed off promptly by a following truck. If the truck needs major repairs, its load is removed and transferred to an extra truck. If able to rejoin the column, it should fall in at the rear of the next march unit that passes.

(4) Repair trucks and extra trucks for replacement purposes travel at the tail of the truck column. Disabled trucks which can be restored to running condition by minor re-

pairs are attended to by the mechanics of the repair trucks. They rejoin the column by proceeding at increased speed. These trucks should not pass other moving march units in order to rejoin their own unit until the columns are halted. Trucks requiring major repairs are towed to the destination by extra trucks; if towing is impossible, they are left alongside the road to be recovered as the situation permits.

■ 153. MOVEMENT BY RAIL.—*a. General.*—(1) In the theater of operations, troop units are moved on standard trains of one or more types, depending upon the type of unit to be moved. The composition of these standard trains is as follows:

Type train	Composition ¹					
	Pull-man	Coach	Box-car ²	Flat-car	Stock	Ca-boose ⁴
A-----	1	11	4	18	-----	(1)
B-----	1	6	4	23	-----	(1)
C-----	6	22	6	-----	-----	(1)
D ³ -----	1	5	2	26	-----	(1)
E-----	1	5	3	-----	25	(1)

¹ Contemplates use of standard railroad equipment. Standard trains of specially constructed light equipment may also be prescribed in theater of operations.

² Includes one combination kitchen-supply car per company.

³ Baggage cars may be used.

⁴ For train crew. Not required when coaches are included.

⁵ For movement of armored units when wheeled vehicles and certain personnel march separately. Personnel with this type train includes two men per vehicle.

Technical units on any given train are usually accompanied by their organic and attached motor transportation and equipment on the same train. However, in some situations it may be desirable to have motor transportation of the units moved by highway in order to reduce rail transportation requirements.

(2) Instructions for a rail movement specify the time it is to begin, entraining points, and number of trains available. In some cases, instructions may include the destination,

detraining points, and future employment of the unit. The commander of a unit ordered to move by rail is especially concerned with orderly entraining and detraining of his unit as scheduled, minimum inconvenience to the troops, security measures at entraining and detraining points and en route, and special supply and administrative arrangements required.

(3) The troop commander has no control over operation of trains. A railway officer accompanies each train and the commander of the troops takes up all railway questions with him.

(4) For details of organization for train movements see AR 55-145.

b. Orders.—The order for a rail movement is similar in form and general content to the march order described in paragraph 152, with modifications in the third paragraph to include entraining points, routes to them, and entraining schedule.

c. Entraining table.—Instructions relative to trains and entraining groups may be incorporated in an annex to the field order, called an entraining table. A form for an entraining table is given in FM 101-5.

d. Conduct of rail movement.—(1) An early reconnaissance should be made of entraining points to determine whether or not adequate loading facilities for vehicles and heavy equipment are available. If not available, they should be provided well in advance.

(2) Each company loads its own baggage and equipment. However, all motor vehicles should be loaded and all cooking equipment installed by one detail for the entire unit.

(3) Motor vehicles are secured against shifting by blocking wheels, strapping down axles, and other means. (See FM 101-10.)

(4) Meals are cooked en route on field ranges installed in the kitchen car. Gasoline ranges must be secured to the floor of the car; wood ranges must be provided with bases of dirt held in place by shallow, tin-lined, wooden boxes.

■ 154. MOVEMENT BY WATER.—*a.* In general, troop movement by water involves movement of large bodies of troops overseas or coastwise, and since such movements are covered

in great detail by orders from higher headquarters, the function of a unit commander is primarily administrative.

b. Ships are loaded in accordance with an embarkation order and schedule issued by the port commander. The unit commander's order for loading is based on these. Troops are marched or transported to the pier at the designated hour and are checked on board by name. Troops load their personal baggage, but normally, prior to the time of embarkation, their organization equipment is loaded by civilian labor or by specially trained troops, in accordance with a detailed plan.

c. For each transport, a commanding officer is designated who has command of all military personnel except casual senior officers. This officer prescribes all routine on board, such as posting of guards. Each day, troop accommodations are inspected throughout, men are exercised and required to bathe if possible, and bedding is aired. Boat and fire drills are held as directed.

d. Debarkation normally is under control of the commander of the port of debarkation or expeditionary force. Before debarking, each unit places a guide on the pier as directed by the debarkation officer; when troops debark, they form on their unit guides. Troops leave the ship by unit or organization. They furnish details for policing the ship and removal of baggage.

■ 155. MOVEMENT BY AIR.—a. The movement of engineer troops by air will usually be limited to airborne divisions and to troops attached to air force units or engaged in work on air force facilities. Equipment and supplies accompanying the troops are kept to a minimum consistent with accomplishing the mission.

b. Movement by air as part of a general offensive for the purpose of disrupting air installations and communications of vital importance to the enemy involves a strong engineer complement. These engineer troops are accompanied by special equipment for repair of landing fields and for destruction of enemy installations.

SECTION II

SHELTERS AND CAMPS FOR ENGINEER UNITS

■ 156. GENERAL.—*a.* Troops may be sheltered in—

(1) Bivouacs, in which troops rest on the ground covered by shelter tents or hastily improvised shelter, or without any overhead cover.

(2) Camps, in which cover is provided by tentage more elaborate than shelter tents.

(3) Cantonments, in which shelter is provided by buildings erected for that purpose.

(4) Billets, in which shelter is provided in public or private buildings.

b. The type of shelter offering the most comfort and protection consistent with the tactical situation should be selected. Bivouacs are used for temporary occupancy, when troops must be held in readiness for action or movement in the near future. Camps and cantonments are best for rest areas, training centers, and concentration areas. Billeting affords immediately available shelter and screens troops from hostile air observation, but troops in billets are not readily available for action.

■ 157. QUARTERING PARTIES.—Shelter areas should be selected in advance by a quartering party sent forward to select camp or bivouac sites, or to locate billets. Members of the quartering party guide units to their areas on arrival, and layout vehicle parks, kitchens, latrines, and bivouac areas for the men, depending on time available and authority delegated to them. They may also do a limited amount of engineer work necessary to provide access to bivouacs and to aid camouflage discipline.

■ 158. SELECTION OF CAMP AND BIVOUAC SITES.—*a.* From the standpoint of comfort and convenience, the following desirable characteristics should be sought in selecting a camp or bivouac site:

- (1) Ample source of potable water, conveniently located.
- (2) Good roads to area, and easy communication within it.
- (3) Room to accommodate the command without crowding.
- (4) Dry ground sufficiently high and rolling to provide good drainage.

(5) Freedom from infection due to soil pollution and disease-transmitting insects such as malarial mosquitoes.

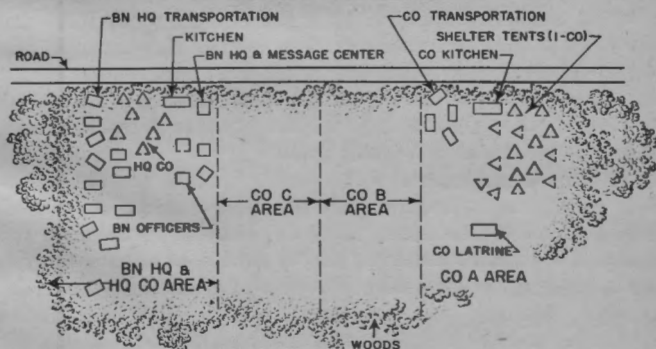
b. From the tactical standpoint, the following points should be considered:

- (1) Expected duration of occupancy.
- (2) Desirability of accommodating entire command in one area.
- (3) Possibility of dispersion and concealment to guard against air observation and attack.
- (4) Suitability for antimechanized defense.
- (5) Availability of alternate sites to which units can move in case of gas attack.

■ 159. SECURITY.—A commander is responsible for the security of his unit at all times. Frequently, security measures provided by other arms afford a large degree of protection. When this is not the case and engineers are sheltered in areas subject to hostile ground attacks, an adequate outpost system must be provided. (See ch. 4.)

■ 160. BIVOUACS.—a. The location and lay-out of a bivouac depends primarily on the tactical situation. A typical lay-out is shown in figure 28.

- (1) When troops are engaged in a movement, bivouacs



SCHEMATIC — NOT TO SCALE

FIGURE 28.—Lay-out of battalion bivouac—diagrammatic (not to scale).

should be located close to the route being used. If security permits, they should roughly parallel the route of march so as to facilitate going into bivouac from march column and leaving it to form march column.

(2) When troops are about to engage in operations, bivouacs should be located as conveniently as possible to the probable site.

(3) When subject to hostile air activity, bivouacs should be located in natural cover. A regular pattern in laying out shelter tents or parking vehicles should be prohibited and full advantage should be taken of existing overhead cover. New paths and roads within the bivouac should be located under cover and should be limited to those absolutely necessary.

(4) When bivouacs need not be concealed and there is no sacrifice of troop comfort, they may be located in open fields with a regular lay-out to facilitate control.

(5) When contact with the enemy is probable, bivouacs are laid out to facilitate going into action promptly. Advantage should be taken of natural obstacles. Vulnerable elements of the command should be in protected positions.

b. Sanitary measures must be initiated promptly and must be strictly enforced. (See FM 21-10.)

(1) Latrines should be dug *immediately* on going into bivouac, normally providing one per company for men and one per battalion for officers. The length and depth of the latrine pit will vary with the number of men using it and the time during which it will be used. Latrines should be located on the opposite side of the bivouac from kitchens, sited so that drainage cannot pollute the water supply.

(2) Where established water-supply points are not available, water-supply facilities are set up as quickly as possible. Water, unless tested and found pure, must be purified. If the source is a stream, watering places should be separated into zones, beginning upstream, for drinking, cooking, watering animals, bathing and washing clothes. Watering places should be marked clearly and guards posted to insure their proper use. Whenever practicable, water purified by the engineer water-purification equipment should be used. If such equipment is not available, water can be purified by boiling, chlorination, and other means.

(3) A garbage-disposal pit 4 feet square by 3 to 4 feet deep is dug for each kitchen. This is used for wet garbage; dry garbage is burned.

c. Vehicle parks should be located so that vehicles can go in and out of the bivouac area quickly and easily without disturbing the troops. Parks should be sited on firm, well-drained ground, preferably where a turn-around is available to eliminate excessive backing. Vehicles should enter the bivouac area single file to avoid making unnecessary tracks.

d. The over-all area required to bivouac any particular unit can be estimated roughly by allowing 50 square yards per man or animal and 100 square yards per vehicle. These figures provide room for all essential facilities without crowding, but do not provide for sufficient dispersion to limit the effects of air attack. When such dispersion must be provided, the estimate may be based on an allowance of 2,500 square yards per vehicle for motorized units, without additional allowance for personnel.

e. When evacuating a bivouac, the site should be policed thoroughly, all refuse burned or buried, latrine and garbage pits filled and posted with a sign giving date of closure and nature of the pit, and all fires extinguished. Each unit commander should inspect his area and have any defects corrected before his unit leaves.

■ 161. CAMPS.—a. Standard tentage for camps consists of large pyramidal tents accommodating eight enlisted men each, with wall tents for the officers. When a camp is to be maintained for several months, floors may be provided if necessary materials are available. Folding cots or improvised lumber bunks may be supplied for all personnel. For cold weather, each tent should be equipped with a stove.

b. Small camps of a temporary nature can be concealed in heavy woods by keeping everything under cover, by using an irregular lay-out, and by proper use of paths and roads. It is practically impossible to conceal large camps, but protective measures include careful camouflage and camouflage discipline, antiaircraft weapons, and passive air defense measures.

c. Extent of water-supply and sanitary facilities provided for any camp depends on the length of time it is to be occu-

pied and the availability of necessary materials and supplies. These facilities may include running water for kitchens and bathing, bathhouses, box latrines, limited electric lighting, and incinerators.

d. Tentage for troops is not a part of the organizational equipment. Necessary tentage is supplied from quartermaster depots on order of higher headquarters, which may erect and maintain camps for use by subordinate units or may turn over tentage to using units for erection.

■ 162. CANTONMENTS (see FM 5-10).—a. Shelter for troops in cantonments in the theater of operations normally consists of simple one-story frame buildings designed to accommodate 50 men. They are provided with wooden bunks for sleeping. Frame buildings are also provided for kitchens and mess halls, quarters for officers, latrines, and bathhouses. Facilities normally include running water for kitchens and bathhouses, electric lights, box latrines, incinerators, recreation buildings, hospitals, a substantial road net and athletic grounds.

b. Theater Headquarters decides on construction and occupation of cantonments in the theater of operations. A unit ordered to a cantonment is assigned definite buildings which the unit commander reassigns to his subordinate units. It is desirable to assign organizations the size of a platoon and larger to separate buildings or groups of buildings.

■ 163. BILLETS.—a. Billeting in dwellings in the United States and possessions is limited, since no troops can be quartered in a private house without consent of the owner, except in certain cases prescribed by law. However, available Federal buildings may be used or private buildings rented. In foreign theaters the use of billets is more common.

b. In assigning billets each tactical unit should be kept intact within one general locality to simplify control and administration. Existing facilities such as water, sewerage, light, and training areas should be utilized fully. It may be necessary to provide additional facilities such as latrines and garbage-disposal points. Frequent medical inspections should be made and sanitary measures must be strictly enforced.

SECTION III

ENGINEER ASSISTANCE TO LARGE UNITS FOR
MOVEMENTS AND SHELTERS IN REAR AREAS

■ 164. GENERAL.—*a.* Large units usually require engineer work to facilitate their movement and to assist in the occupation of new shelter areas. This work generally consists of—

(1) Providing facilities and assistance for loading and unloading at entraining, embarkation, detraining, and debarkation points.

(2) Maintaining roads for movements by foot and motor.

(3) Making preparations to receive a unit at its destination.

(4) Providing or improving facilities in shelter areas.

b. To accomplish these tasks it is normally necessary to keep some engineer troops at the starting point until all or the bulk of the force has departed; to send other engineer troops to the destination before the bulk of the force arrives; and in some cases involving truck or rail movements, to have engineer troops accompany certain elements of the force during the movement.

c. In general, engineer assistance should be limited to work for the benefit of the command as a whole, or to work for which engineers are better trained and equipped than other troops. Other arms should provide their own facilities as far as practicable.

■ 165. ENTRAINING POINTS.—*a.* Work done by engineers at entraining points may include the following:

(1) Constructing or strengthening ramps and loading platforms for matériel.

(2) Constructing or improving routes of approach for vehicles to entraining points.

(3) Constructing or improving railway spurs and sidings.

(4) Assisting troops of other arms in loading.

(5) Converting railway cars for special uses, such as modification of boxcars to accommodate animals.

b. Entraining points should be chosen so as to require a minimum of new construction or improvement. Work most frequently required will be construction of loading ramps

and platforms (see FM 25-10). Loading facilities are of the two general types described below.

(1) *Side loading*.—A platform with a ramp at one end is constructed parallel to the railway track with a height above the top of the rail of 3 feet 9 inches, a clearance from the center line of the track of 6 feet, and a minimum width of 10 feet. The length of a platform for loading one flatcar at a time is 40 feet. Incline of the ramp should not exceed a 20 percent slope. Platforms and ramps may be built of timber or may be improvised.

(2) *End loading*.—A ramp is constructed at the end of a siding or spur or on a through track so that vehicles can load directly from the ramp to a flatcar. The gaps between adjacent flatcars in the train are bridged by spanning platforms. These may be made from 3- by 12-inch planks 4 feet long, cleated together on the under side and placed across the gaps under each tread. Ends of planks should be beveled. All vehicles then load from the end of the train and close up on the most forward flatcar until all flatcars are loaded. When the ramp is built on a through track, that part of the track which must be traversed by vehicles should be protected by decking. Decking is laid parallel to the rails and should cover the ties both between and outside the rails. In loading heavy tanks, the end of the flatcar next to the ramp should be supported on heavy blocks so that the impact will not damage the car springs or truck. End-loading ramps may be built in the same manner as platform ramps. A ramp may be improvised by removing a truck from the end of a flatcar; it is then only necessary to bridge the short gaps at each end of the inclined car. Railway car jacks facilitate raising and lowering the car to remove and replace the truck. The steel treadways of the steel treadway bridge carried by the treadway bridge company of an armored division make excellent end-loading ramps.

■ 166. EMBARKATION AND DEBARKATION POINTS.—These points normally will be located at ports with existing facilities generally adequate for military needs. When engineer work is required, it will usually consist of minor repairs to existing wharves and improvement of existing routes of approach. If new facilities must be constructed, experts should design and lay them out.

■ 167. **ROADS.**—*a.* Major traffic movements by road, involving either wheeled or track-laying transportation, should be preceded by a detailed route reconnaissance by engineers. This reconnaissance should furnish complete information as to capacities of bridges, loads which roads can carry without surface injury, and density and speed of traffic which roads can bear without undue wear and tear. Basing his decisions on this information, the unit engineer concerned should make recommendations as to routes to be followed and maximum speeds to which vehicles should be restricted. He should estimate the amount of engineer work required to put routes in proper condition and the time required to perform this work.

b. Engineer work necessary to put roads in condition for a troop movement should be completed before the move starts. Such work consists generally of strengthening existing bridges and making minor repairs to road surfacing. Routes should be chosen so as to eliminate need for new construction or extensive repairs.

c. Sufficient engineer troops should accompany advance elements of the force to do whatever work is necessary to meet contingencies on the march. Likewise, engineer troops should be located in the march column or columns so as to be readily available to do work which is beyond the capacity of the engineers with advance elements, and to do any maintenance work which may become necessary as the force advances.

■ 168. **WORK AT DESTINATION.**—*a.* Troops moving on foot or by truck should be able to move their organic and attached transportation off the road and into their bivouac or similar area without halting. To permit this, engineers may have to construct temporary crossings over roadside ditches and gullies, improve secondary roads and trails, and clear new trails.

b. At detraining points engineer work is similar to that at entraining points.

■ 169. **SHELTER AREAS.**—*a.* Engineer work in shelter areas consists of the following tasks (see FM 5-10):

(1) *Water supply.*—(*a*) Providing adequate source.

(*b*) Installing and operating water-purification units.

(c) Erecting and maintaining water-storage facilities, varying from portable canvas tanks for bivouacs to permanent tanks of wood, steel, or concrete for cantonments.

(d) Preparing and operating bathing facilities for men and watering points for men and animals.

(e) Installing and maintaining water mains and piping for camps and cantonments.

(2) *Roads.*—(a) Improving, constructing, and maintaining roads, railroads, bridges, and culverts needed for supply and communication in shelter areas.

(b) Providing and placing signs for traffic routing and control.

(3) *General construction.*—(a) Performing all construction and maintenance work for cantonments in the theater of operations.

(b) Erecting tent camps.

(4) *Electric power.*—(a) Installing and operating electric generating equipment for lighting or other use.

(b) Installing and maintaining electric power lines and wiring.

(5) *Special work.*—Constructing and maintaining special works, such as camouflage and protected shelters for important installations, as directed by the force commander.

b. In all cases, full use should be made of existing facilities to reduce new construction needs. This applies particularly to water and electric facilities, roads, and railroads.

c. When a large unit such as a division moves into a shelter area for rest and training, the engineer component of the unit occupying the shelter area should receive the same amount of rest and training as other units. The engineer work for the maintenance and improvement of the area should be done by other engineer troops furnished by the unit engineer responsible for engineer work in that general area.

CHAPTER 9

TRAFFIC CIRCULATION AND CONTROL

	Paragraphs
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SECTION I

GENERAL

■ 170. GENERAL.—*a.* Traffic in combat areas must move in accordance with a circulation plan based on the military situation and a thorough study of road capacity and condition. When the road net is extensive and traffic is light, traffic control is simple unless complicated by enemy activity. When the road net is limited, or traffic heavy, need for coordination and control is greater. The general doctrine of traffic circulation and control is found in FM 101-15. Traffic management, with particular reference to motor transport, is covered in FM 25-10 and with reference to the responsibility of military police in FM 29-5. This chapter is primarily concerned with engineer duties in traffic circulation and control.

b. Principal measures for facilitating traffic movement are:

(1) Preparation and issuance of the traffic-circulation plan to include—

(*a*) Reservation of separate roads at specified times for tactical movement of troops. When lack of sufficient roads makes reservation of separate roads for different types of traffic impracticable, different types of traffic may be allotted the same road at different times.

(*b*) Provision of circuits of one-way roads; two-track roads may be used for one-way operations when advantageous.

(*c*) Restrictions on use of lights, specification of maximum allowable density, and other protective measures.

(*d*) Limitations on types or weights of loads using certain routes.

(2) Establishment of necessary traffic-control posts and traffic patrols for enforcement of traffic regulations and guidance of movements on roads.

(3) Provision of an ample supply of traffic-circulation maps and other road maps.

(4) Erection and maintenance of legible and readily understood traffic signs to indicate authorized directions of movement and locations of units and establishments.

(5) Rigid enforcement of traffic regulations and march discipline.

(6) Provision for maintenance and construction of roads and bridges as required for operation of traffic-circulation plan.

(7) Provision of adequate communication for traffic control by telephone, radio, or aircraft.

■ **171. PRIORITY.**—Priorities of traffic are determined by the general staff. Designation of traffic priority is based on tactical and administrative considerations. Comparative urgency of conflicting movements is used as a basis for determining priority. As a rule, however, requirements of combat troops are given first consideration. Under certain conditions, priority may be given to engineer troops and trucks loaded with road and bridge material. Forward movements normally have precedence over other movements. Loaded vehicles usually have priority over empty vehicles. Isolated vehicles of troop commanders, staff officers, and messengers are allowed freedom of movement whenever possible.

■ **172. DUTIES AND RESPONSIBILITIES.**—*a. General.*—Planning and supervising traffic circulation and control is a function of command. In exercising this function the commander is assisted by his staff and by other agencies under his command. Duties and responsibilities of these agencies are shown in figure 29. Formulation of a plan for traffic circulation and for control measures is a function of the G-4 section of the general staff, and a portion of the G-4 section is organized into a traffic headquarters to assist in this work. The plan must be coordinated with those of other staff officers, especially with the plan of the G-3 section for movement of troops. When approved by the commander, the

necessary elements of the plan are published in orders. They may be included in field orders or administrative orders, or in annexes to them. In corps and field armies a circulation map normally is used as an annex to an administrative order.

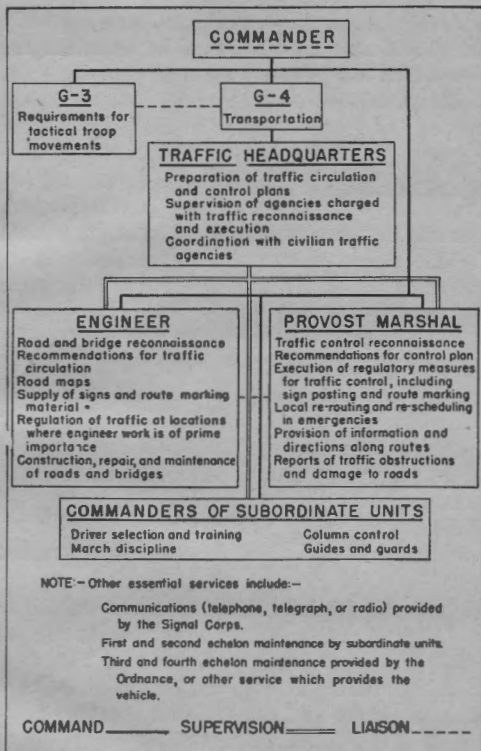


FIGURE 29.—Organization for traffic circulation and control.

b. Traffic headquarters.—G-4 of each division and higher unit and of ports of embarkation and similar administrative headquarters has an assistant who is charged with the operation of a traffic headquarters. The traffic headquarters of each unit assists G-4 by planning traffic circulation and

control within the unit area and by assisting in the supervision of all matters which directly affect traffic circulation and control. Its duties include the following:

(1) Receipt, correlation, and dissemination of traffic information.

(2) Preparation of traffic-circulation and control plans.

(3) Supervision and coordination of agencies furnishing traffic information and executing traffic plans.

(4) Coordination with civilian traffic authorities.

(5) Rendition of traffic reports to higher and lower headquarters.

(6) Supervision of driver selection and training.

c. The engineer.—The unit engineer assists the commander in the formulation and execution of those portions of the plan for traffic circulation and control which are affected by the condition of roads and bridges. The work of the engineer in this respect is supervised by G-4 and the traffic headquarters of the unit. Duties of the unit engineer with regard to traffic circulation and control are to—

(1) Conduct continuous engineer reconnaissance on location and condition of roads and bridges, and on local resources for their improvement, maintenance, and repair.

(2) Submit reports to unit commander of results of engineer reconnaissance.

(3) Recommend a plan of traffic circulation consistent with engineering limitations of road net and available engineer troops.

(4) Supply maps and overlays for use as an aid to traffic.

(5) Supply signs and material for marking routes and directing traffic.

(6) Construct, maintain, and repair roads and bridges.

(7) Regulate traffic on bridges or at other places when engineer work or structural limitations necessitate.

(8) Assist traffic moving over difficult portions of road net.

d. The provost marshal.—The provost marshal assists the commander in formulating and executing those portions of the plan which are concerned with enforcement of traffic control measures. Duties of the provost marshal in this connection are to—

(1) Conduct reconnaissance to determine best means for enforcing plan of traffic circulation.

(2) Recommend plan of enforcing traffic-control measures.

(3) Execute regulatory measures for traffic control including sign posting and route marking.

(4) Prepare and execute plans for local rerouting and rescheduling in emergencies.

(5) Provide for information and direction along routes.

(6) Report traffic obstructions and damage to roads.

SECTION II

CONSIDERATIONS AFFECTING TRAFFIC-CIRCULATION PLAN

■ 173. GENERAL.—Engineers are primarily concerned with formulating the plan of circulation rather than with measures for enforcing it. The principal considerations affecting the traffic-circulation plan are:

- a. Tactical situation.
- b. Roads and road net.
- c. Facilities for maintenance and improvement of roads.
- d. Types of transportation used.
- e. Supply and evacuation situation.
- f. Restrictions by higher authority.
- g. Civilian traffic.
- h. Weather conditions.

■ 174. TACTICAL SITUATION.—Immediate requirements for combat must be given primary consideration in all traffic-circulation plans. In the formulation of such a plan all traffic movements should be allotted such roads and periods of use as will insure arrival at the destination at the proper time with the least possible fatigue. After a plan has been formulated and put into effect, it often will be changed because of enemy action or other circumstances, time and distance normally being the controlling elements. Tactical necessity may demand utilization of roads for troop movements without regard to the circulation plan used for supply and evacuation or other purposes. The circulation plan itself and methods of control of traffic must be flexible, so that when unforeseen events change traffic conditions, prompt adjustment may be made without delay or confusion.

■ 175. **ROADS AND ROAD NET.**—*a. General.*—The road system should be adequate to allow for necessary troop movements, to carry all supplies from railheads and truckheads, to supplement the rail system by relieving it of part of its load, and even to replace the railroad entirely during temporary break-downs. Information as to the road system is gathered by engineer reconnaissance, and must be available in comprehensive and easily understood form for consideration in formulating the plan of traffic circulation. Opportunities for improving the usefulness of the road system by limited amounts of engineer work at road junctions, narrow bridges, or other critical points, should also be sought.

b. Types.—The classification of roads with regard to materials, construction, maintenance, and repair is given in FM 5-10. Various classifications with regard to traffic characteristics are given below.

(1) *Direction of traffic.*—A one-way road is a road on which traffic moves in one direction only. It may be either a one-lane road or a road having more than one lane. A two-way road is one on which traffic moves simultaneously in both directions. It may be classified as one plus or any higher designation with respect to lanes.

(2) *Classification of roads.*—Paragraph 30 gives a system of symbols used for the general classification of roads.

c. Traffic capacity and flow.—(1) *General.*—Traffic capacity must be considered in the preparation of the traffic-circulation plan. Traffic flow is limited by traffic capacity and other considerations, such as security.

(2) *Traffic flow.*—Traffic flow is defined as the number of vehicles passing a given point in a given period of time (for example, 500 vehicles per lane per hour). Tables showing traffic flow for motor marches in close or open column or by infiltration are given in FM 25-10.

(3) *Traffic capacity.*—Traffic capacity is defined as the maximum traffic flow attainable with close-column marching using all available lanes. It can be increased only by the improvement of facilities. Traffic capacity is dependent on the number of lanes and on roadway features influencing speed, such as width of lanes and shoulders, type and condition of surface, curvature, gradient, and traffic bottlenecks.

d. Emergencies.—Road and bridge conditions are not static but change frequently because of heavy traffic, weather conditions, enemy action, and maintenance activities. The circulation plan should include allowance for changes which are expected to occur and should be sufficiently flexible to meet unforeseen contingencies. The unit engineer should make prompt recommendation when changes in the plan become necessary.

■ 176. **FACILITIES FOR MAINTENANCE AND IMPROVEMENT OF ROADS.**—The successful operation of a plan of traffic circulation is contingent upon the maintenance in operation of certain critical routes. It may also require that traffic capacity of principal routes be maintained at certain minimum levels. Therefore an important consideration in the traffic-circulation plan is the availability of necessary troops, equipment, and materials to meet the minimum needs for road maintenance and repair. This necessitates a study of engineer resources in the area.

■ 177. **TYPE OF TRANSPORTATION USED.**—The only type of divisions which include animal-drawn transportation are cavalry and mountain divisions. The traffic circulation plan for most units therefore need provide only for movements of motor vehicles and troops on foot. Some heavy artillery is drawn by tractors and has a lower rate of march than truck columns; such columns may require special regulations to prevent unnecessary interference with other units. The 2½-ton cargo truck, which weighs about 8 tons loaded, is the standard vehicle for supply purposes. Tables of weights of other standard vehicles are found in FM 5-10.

■ 178. **SUPPLY AND EVACUATION PLAN.**—*a. General.*—The subject of supply and evacuation, including general supply principles, classification of supplies, nature and locations of supply and evacuation establishments, and classification and operations of trains, which must be considered in the formulation of a traffic-circulation plan, is covered in FM 100-10 and FM 100-15.

b. Location and establishments.—Locations of the supply, evacuation, and administrative establishments serving the

unit must be known before the traffic-circulation plan can be completed. These establishments include:

- (1) Supply point for class I supplies.
- (2) Supply point for gasoline and oil.
- (3) Ammunition-supply point.
- (4) Engineer supply point.
- (5) Water-supply points.
- (6) Collecting stations.
- (7) Clearing station or stations.
- (8) Bivouacs of various service units.
- (9) Bivouacs of various regimental and lower unit trains.
- (10) Command posts of unit and next lower echelons.
- (11) Rear echelon of unit headquarters.

■ 179. RESTRICTIONS BY HIGHER AUTHORITY.—Restrictions imposed by higher authority may have an important influence on the traffic-circulation plan of a subordinate unit, and must be rigidly adhered to in the formulation of a traffic-circulation plan.

■ 180. CIVILIAN TRAFFIC.—*a.* Successful military traffic control requires in many cases effective regulation of civilian traffic. Any mass movement of civilians within the combat zone, unless properly controlled, may result in complete stoppage of all military traffic.

b. The most critical problem of civilian traffic control arises in connection with refugee movements. Refugee movements must be controlled by requiring—

- (1) Evacuation prior to or during a lull in military movements.
- (2) Use by refugees of roads or trails carrying little or no military traffic.
- (3) Diversion of refugee traffic from areas important for military operations.
- (4) Organization of refugee traffic in march columns, with movements directed so as to cause least interference with essential military traffic.

■ 181. SYSTEMS OF CONTROL AND TECHNIQUE.—The plan of traffic circulation is normally based on the above considerations, and a plan of control is then developed to provide enforcement. However, in some cases the plan of circulation may be modified by limitations on enforcement means. For

this reason the systems and techniques of traffic control must be understood by engineers. Engineers may also be required to apply this knowledge to provide for movement of engineer troops and control of traffic at locations where engineer work is of prime importance. Traffic control is discussed in section IV.

SECTION III

FORMULATION OF TRAFFIC-CIRCULATION PLAN

■ 182. BASIC REQUIREMENTS.—The traffic-circulation plan should be the simplest that will serve the needs of the situation. Unnecessary regulation or restrictions on use of roads are avoided. Circulation is rarely prescribed forward of the bivouacs of the rear echelons of the front-line infantry regiments, since dense and continuous traffic is not expected forward of these points. When the road net is extensive and traffic is light, the only restrictions ordinarily imposed on traffic are to insure that roads and bridges having low capacities or clearances are not used for traffic beyond their limitations. Rapid deterioration of the road net results from excessive speeds, overloading on roads and bridges, heavy and continuous traffic on roads with a poor surface or subgrade, and use of roads and bridges in need of repair. Maintenance requirements must be kept within the capabilities of available engineer means.

■ 184. MAIN SUPPLY ROAD.—*a. Purpose.*—Keeping all roads open at all times may be impractical or physically impossible because of the amount of engineer work involved. Since it is desirable that at least one axial route be kept in good condition for each division, one road, known as the main supply road, is ordinarily designated as the route to be kept open. It is normally designated as extending from the division rear boundary to the artillery position areas in the defense and through to the division objective in the attack.

b. Basis of selection.—The main supply road should be chosen because it possesses as many as possible of these characteristics:

(1) Bridges of adequate strength for all division loads.

(2) Roadway wide enough for use by two-way traffic. For short stretches, a one-way loop may be incorporated in it if the situation requires. A one-way loop may be used for

entire main supply road, but this usually involves unnecessary movement of trains.

(3) Surface which will stand up under the traffic conditions and weather expected. An all-weather road is preferable.

(4) Ease of opening and maintenance with minimum loss of time and a minimum of engineer troops and materials. This is especially important in the advance, since the enemy may be expected to destroy all bridges and the roadway at other vulnerable points.

(5) Location along axis where bulk of supplies of division will be used. Thus, in the attack the main supply road normally should follow axis of main attack.

(6) A position protected so far as possible from ground attack, air bombardment, and artillery fire. Thus, main supply road should not be on an open flank subject to raids by enemy reconnaissance vehicles, and it should not cut laterally across the sector of the division in forward areas. Advantage should be taken of concealment from aerial observation afforded by overhanging trees.

(7) It should be as short as possible.

c. Use.—The main supply road is not intended to be the road on which all supply and evacuation vehicles move. On the contrary, traffic normally is dispersed over all roads not reserved for some other specific purpose. Overconcentration of traffic on the main supply road must be avoided, and control exercised to regulate all traffic thereon during critical periods when other roads are not available.

■ 184. ONE-WAY ROADS.—*a. General.*—Ordinarily, multiple-lane roads are operated as two-way roads unless one-way traffic is absolutely necessary. One-way routing is not prescribed without careful study as to its full effect on traffic both on the roadway concerned and the road net as a whole. Thus, care is exercised to insure that access to or egress from any installation is not denied to traffic, that time required for movement between important terminals is not unduly increased, that vehicles are not forced to use hazardous roads unnecessarily, and that long backhauls are not required. Ordinarily, a one-way route in one direction is paired with an adjacent one-way route in the other, to accommodate

traffic in both directions. The use of a one-lane road alternately in opposite directions may be necessary because of unavailability of other routes, or may be advisable because of time consumed in use of circuitous routes. However, such use ordinarily involves traffic delays and requires a well-organized control system. Whenever the need for one-way routing ceases, restrictions on direction of movements are withdrawn promptly and one-way signs removed.

b. When prescribed.—One-way movement may be prescribed under the following conditions:

(1) On one-lane roads. These must be operated as one-way roads either permanently in one direction or alternately in opposite directions.

(2) On multiple-lane roads when full traffic capacity of roadway is desired for movement in a single direction.

(3) When traffic flow can be facilitated by reducing number of conflicting traffic streams, especially during blackout conditions.

(4) When it is essential to simplify traffic control at heavily traveled or complex intersections.

(5) When two parallel roads form a loop that will permit traffic to move to its terminal by one road and return by the other without greatly increasing distance between terminals.

■ 185. PREPARATION OF PLAN.—Preparation of the traffic-circulation plan consists of studying all available pertinent information and prescribing the use of all important roads in the road net. The following specific steps are involved in preparing this plan:

a. Restrictions imposed by own or higher headquarters.—Any roads within own or lower unit areas which are reserved or otherwise restricted by own or higher headquarters must be indicated in the circulation plan.

b. Restrictions imposed by physical characteristics or roads.—Widths, clearance heights, and load capacities of critical structures, number of traffic lanes, and type and condition of surface must be indicated in the circulation plan to prevent use of roads by traffic which cannot be accommodated.

c. Locations of terminals.—Location and classification of supply, evacuation, and administrative establishments

in the area should be indicated in the circulation plan.

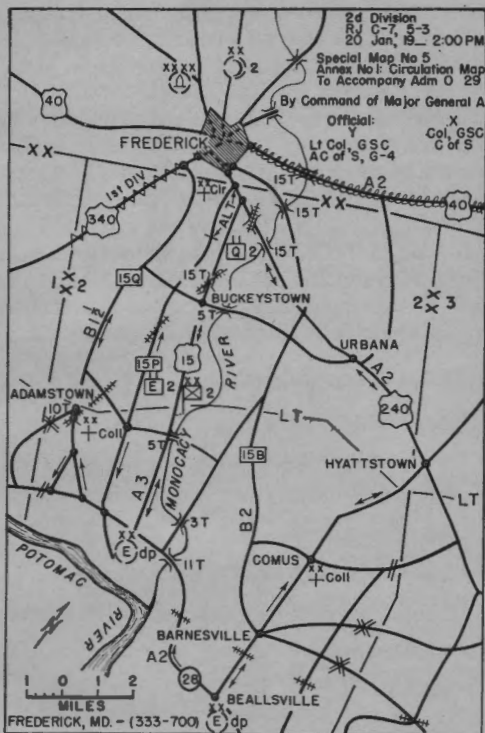
d. Routes and direction of movement.—Movement of traffic may be facilitated by organizing the road net into a system of routes, prescribing permissible directions of movement throughout. Routes in each area should tie in with routes established in other areas by higher, lower, and adjacent headquarters. The designation of each route, and, whenever possible, the prescribed direction of movement should be consistent in all areas through which the route passes. In establishing routes in forward areas, special attention should be given to roads and intersections known to be under enemy fire. Cities which have not been evacuated and other congested areas should be bypassed whenever possible. In friendly territory, the aid of civilian authorities will be helpful in drawing up detailed plans for routing traffic through cities which cannot be bypassed.

e. Roads crossing boundaries of area.—The road net for each subordinate unit is generally confined to the limits of the tactical area assigned to such a unit. However, in cases where communication of any lower unit with rear area installations depend on the use of a road or roads passing through the tactical area of an adjacent unit or where a road lies on the boundary between two units, regulations governing the use of these roads by the adjacent lower units must be prescribed by the higher headquarters.

f. Tests.—The last step is to test the circulation plan with respect to functioning of trains, flexibility, and maintenance requirements. Satisfactory routing for normal movements of all supply trains between terminals must be available. Normal troop movement should be practicable without major interference with the circulation system. Satisfactory solutions should be available to traffic problems likely to be introduced by the blocking of important roads at vulnerable points. Maintenance requirements of the routes to be used must not exceed the capabilities of the facilities available. Traffic should not be such as to prevent rapid movement of mobile reserves for counterattack.

g. The circulation map.—The circulation plan, issued as an annex to the field or administrative order, consists of a map or an overlay. On this map or overlay the road net with all essential road data, the location and classification

of important terminals, and the prescribed circulation on roads are shown. Control classification of roads may also be shown. A typical circulation map for a division defending a river-line area is shown in figure 30. Symbols used are explained below.



LEGEND










- | | | |
|--|---|--|
| ← ONE-WAY TRAFFIC |  15 | FEDERAL MARKER |
| ↔ TWO-WAY TRAFFIC |  28 | STATE MARKER |
| ← ALT. ONE-WAY TRAFFIC |  5A | MILITARY ROUTE MARKER |
|  DISPATCH ROUTE |  T | TRAFFIC POST (OR UNIT) |
|  RESERVED ROUTE |  T | TRAFFIC HQ |
|  86
23 |  A2A3
B14 | MARKED ROAD
INTERSECTION
ROAD CLASSIFICATION |

FIGURE 30.—Traffic circulation map.

h. Map symbols.—The symbols given below to indicate traffic information are used in addition to those shown in paragraph 30. Road information appearing on the map applies throughout the length of road between points shown by heavy dots or crossbars.

H Followed by numeral, indicates clearance height in feet between surface of roadway and overhead obstruction.

W Followed by numeral, indicates clearance width in feet provided at most critical place. Symbol is preceded by numeral to indicate more than one such lane (2 W 9 indicates two separate lanes, each of which provides a clearance width of 9 feet).

T Preceded by numeral, indicates tonnage limitation. (See par. 191.)

M Preceded by numeral, indicates distance in miles.

I Followed by numeral, indicates average interval of time (time-distance) in minutes required by motor vehicles during daylight to travel section of road shown.

	Road block, proposed.
	Road block, prepared but passable.
	Road block, completed.
	RR grade crossing.
	RR above road.
	RR beneath road.
	Boundary between two sections of roadway.
	Impassable road.
	Bridge.
	Tunnel.
	Rotary traffic.
	Turnaround location.
	Line drawn parallel to one-lane road indicates length of roadway where passing is possible.

■ 186. SUMMARY.—From the foregoing, the following general rules relative to traffic circulation and control may be stated:

a. Engineer reconnaissance must precede preparation of a traffic-circulation plan.

b. Preparation of the plan is a function of G-4 section of the staff and is based in part on recommendations of unit engineer.

c. Requirements of combat troops must be given first consideration.

d. Plan must be flexible to meet various contingencies.

e. Traffic restrictions should be held to the minimum.

f. Traffic circulation is regulated with reference to location of fighting front and to supply, evacuation, and administrative establishments.

g. Separate roads for troop movements by various means (motor, foot, animal) should be allotted, if required, for necessary periods of time.

h. Cross currents of traffic should be avoided as far as practicable, including left turns against traffic.

i. Clear and legible signs indicating prescribed directions of traffic and locations of establishments should be provided.

j. Circulation maps should be furnished to all agencies requiring them.

k. Rigid and impartial enforcement by all commanders of traffic-control regulations and of march discipline is essential.

l. Provision should be made for necessary road construction and maintenance work by engineers.

m. Tentative plans should be prepared and revised as necessary to meet all possible changes in tactical situation.

SECTION IV

TRAFFIC CONTROL OPERATIONS OF ENGINEERS

■ 187. GENERAL.—Traffic control is a normal function of military police. A detailed discussion of traffic control technique including signals used by traffic police is given in FM 29-5. Engineers normally control traffic only when it is necessary for the performance of their primary duties. Such cases include traffic control measures to facilitate movement of engineer troops, and traffic control at critical bridges, engineer supply points, and at the site of road and bridge repairs. Engineer troops are not trained in the detailed technique of

traffic control but have basic knowledge sufficient for localized traffic control work in forward areas. Whenever practicable, engineers secure the assistance of military police in the handling of traffic problems. Engineers also assist in traffic control by furnishing signs which are posted by the military police.

■ 188. SYSTEMS OF TRAFFIC CONTROL.—There are two general systems of control: organizational and area. The one to use in a particular situation depends upon the number of routes available, traffic conditions, and tactical considerations.

a. Organizational.—Under organizational control, traffic personnel from an organization on the march exercises control, usually by means of an escort. The escort regulates traffic only along the route traveled by the column and only so far as necessary to insure its free movement in accordance with its priority, with minimum interruption of other traffic of lower priority. This type of control is used chiefly in movements of individual units when conflicts with civilian or less important military traffic is all that is anticipated.

b. Area.—Under area control, headquarters responsible for traffic control in the area assigns traffic personnel to regulate all traffic in accordance with the circulation plan in effect. Area control is used chiefly when large-scale traffic operations are being conducted and when a single unified control over all traffic on a road net is necessary. (See FM 29-5.)

■ 189. TECHNIQUES.—There are three techniques of traffic control: intersection regulation, escort, and patrols, all of which may be used in area control.

a. The intersection regulation technique uses traffic control posts at road intersections and other bottlenecks such as bridges, road blocks, or narrow stretches of road. It is the duty of each control post to enforce the special traffic orders in effect there, to enforce compliance with general traffic regulations, and to assist units in maintaining march discipline. When it is possible to do so without having the information fall into the hands of the enemy, it is desirable to supply each post with the following material: copy of circulation map, copy of any special traffic control orders,

priority list, march tables or march graphs covering movements of large units, signboards showing directions and distances, location of nearby command posts, and red and white lanterns for use where lights are allowed.

b. Regulation by escort technique consists of having motor traffic control groups proceed in advance of each column along the routes to be followed. They notify such control agencies as exist to block off all traffic until troops or columns have passed. At crossings, supply points, and other places where there are no control posts, they take station far enough ahead to insure the march being made without interference by other traffic of lower priority. When the head of the column reaches a post thus established, the escort proceeds to the next unposted point, clearing the road as it goes. This procedure is carried out until the troops have reached their destination. This system is best employed where the column using it has first priority on the roads used.

c. Regulation by patrol technique consists of using motorcyclists who, singly or in groups of two or more, constantly patrol the roads between traffic control posts. They are charged with the same general duties as traffic control posts. Patrols should be furnished the same kinds and means of information as traffic control posts.

d. A combination of intersection regulation and patrols normally is required in area control. The escort method is often used in organizational control. Each technique must be used to best advantage, and all must be coordinated into a good control plan.

■ 190. TRAFFIC CONTROL FOR ENGINEER TROOP MOVEMENTS.—a. When engineer units move as a part of a larger column including other troops, the movement of the column is controlled by the commander of the serial and the engineer commander has no responsibility for traffic control other than that of enforcing compliance with traffic regulations by the vehicles of his own unit. Small engineer units may move independently by infiltration and in such a case the necessary traffic control measures are provided by the area commander.

b. When a small engineer unit moves independently as a march group, escorts are usually provided by the engineer

unit commander to supplement the area control provided by the area commander. Motorcycles may be withdrawn from subordinate engineer units to provide escorts. Troop movements of large engineer units in rear areas are normally executed in accordance with the traffic control plans of the area commander. The area commander may assign special priorities to such movements and provide escorts of military police personnel. These and other traffic control measures of the area commander are ordinarily supplemented by escorts provided by the engineer unit for internal police of the column and to assist other traffic control agencies.

■ 191. **ENGINEER CONTROL OF LOADS MOVING OVER CRITICAL BRIDGES.**—Engineers are charged with control measures when necessary to prevent damage to bridges or other engineer structures.

a. Minor bridges.—Engineer personnel normally is not employed for control of traffic over minor bridges, the destruction of which by improper use would not seriously affect traffic circulation. Bridges which can be readily replaced or bypassed fall within this classification. Normally, traffic control measures at such bridges consist only of posting signs to indicate the maximum loads or other restrictions on the use of the bridge.

b. Important bridges.—Important bridges whose destruction or damage would seriously affect traffic circulation and which might be injured by improper use are usually guarded by engineer personnel. The extent of the personnel and facilities required for this purpose varies with the nature of the bridge and the traffic conditions.

(1) Where traffic is light, and turn-arounds are available near the ends of the bridge, a single guard for a short bridge or a guard at each end of a long bridge may be adequate. These guards should examine all vehicles attempting to use the bridge and turn back those which might damage it. They should be provided with tables showing the classes of vehicles which can or cannot use the bridge, and with circulation maps showing detours available for use by the heavier vehicles. The guards may also be provided with materials and tools for minor maintenance of the bridge.

(2) Where traffic is heavy, more extensive plans are re-

quired for examining vehicles and turning back those which cannot be allowed to use the bridge. Guards may be employed at the bridge to insure that vehicles cross at correct speed and interval, but guards provided to turn back unsuitable vehicles should be posted at a safe distance from the bridge and at a location where there is adequate space for turning vehicles around and rerouting them without interfering with other traffic. Bridge guards utilized for this purpose ought preferably to be placed in the vicinity of the road intersections nearest the ends of the bridge. One guard should be posted on each main road approaching the bridge. This guard should hastily inspect all vehicles, instructing drivers of those vehicles which require more detailed examination to turn out of the column at the intersection or at some other designated location. At this location, sufficient space should be provided for the dispersal of vehicles being examined and for maneuvering them as necessary to dispatch them to their destinations. Engineer personnel at these locations should be provided with tables showing the types of vehicles permitted to cross the bridge and should be capable of making additional calculations when required by loading conditions or unclassified vehicles. Whenever possible, military police assistance should be provided to handle traffic at such locations.

■ 192. CONTROL OF TRAFFIC THROUGH ONE-WAY DEFILES.—The control of traffic at the site of engineer work also frequently involves moving two-way traffic through a one-way defile. Whenever possible, engineer work is conducted in such a manner that it will not interfere with two-way use of roads which normally accommodate two-way traffic. However, in many cases, it is necessary to block all lanes except a single one and to operate this as one-way defile. This may be necessary in making repairs to bridges or roads partially blocked by enemy bombardment or for maintenance and improvement work such as filling chuckholes, placing road oil, or reconstructing culverts.

a. Traffic movement through a short defile on a road carrying light traffic can be handled informally by visual signals from a guard placed at the center of the defile.

b. (1) Long defiles require more extensive provision for

control of two-way traffic. Generally, the minimum requirement is that one guard be placed at each end of the defile to halt traffic and direct it through the defile when notified by the guard at the other end that the route is clear. This can be done most simply by the use of a baton or other signal which is handed to the driver of the last vehicle of a group passing through the defile who delivers it to the guard at the exit. The guard at the exit then knows that the route through the defile is clear and dispatches vehicles in the opposite direction, turning over the baton to the driver of the last vehicle. Supplementary means of communication, such as telephone, may be provided, and patrols may be employed to regulate traffic within the defile. For a long stretch of road under repair, a number of short defiles separated by stretches of two-way roads will provide greater traffic capacity than a single long defile.

(2) When traffic through a one-way defile is heavy, special measures may be required to prevent the creation of exceptionally vulnerable targets for enemy aviation. These measures include the routing of as much traffic as possible by other roads, provision of dispersal areas at each end of the defile where vehicles can be moved off the road while awaiting their turn to pass through the defile, provision of traffic-control posts at some distance from the entrances of the defile to warn traffic against closing up before coming to a halt, and provision of traffic patrols to enforce these measures.

■ 193. PONTON BRIDGES.—Ponton bridges require extensive traffic control measures since they generally form a part of long one-way defiles and since many of them have a low load capacity. Whenever possible, a ponton bridge should be operated as a part of a one-way route. When this is done, traffic control measures consist primarily of regulating traffic on the bridge and rerouting vehicles which are too heavy to cross. (See par. 191.) When two-way traffic must be accommodated on the bridge, traffic control posts are established some distance from each end of the bridge to reroute vehicles which are too heavy, and to control the alternate movement of traffic in easy direction as described in para-

graph 192. Telephone communication is provided in ponton units to assist in traffic control.

■ 194. **TRAFFIC CONTROL AT SUPPLY POINTS.**—At engineer supply points or water-supply points, special traffic control measures may be necessary to provide access to main routes and to regulate movement within the supply point. Whenever practicable, regulation of traffic at the intersection between the access road and main route is provided by military police, but engineers may control such intersections when necessary. This is normally done by placing one man at the intersection to direct traffic. Within the supply point, traffic control posts may be established to give instructions to drivers as to routes and methods of conduct. Patrols may be employed to see that these instructions are complied with.

■ 195. **TRAFFIC CONTROL AT SITES WHERE ENGINEER ASSISTANCE TO VEHICLES IS NECESSARY.**—Engineers regulate traffic at places where engineer assistance is being given vehicles negotiating difficult terrain. The main objective is to prevent the jamming of vehicles in such a manner as to interfere with the assistance being rendered, or so as to create favorable targets for enemy aircraft. Engineer assistance of this type may be given at approaches to ferries in muddy or sandy areas, at deep fords, or in the passage of steep-sloped areas covered by mud, snow, or ice.

CHAPTER 10

ENGINEER SUPPLY

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SECTION I

GENERAL

■ 196. **GENERAL.**—Organization of a theater of operations and administrative functions therein are prescribed in FM 100-10 and 100-15. For supply definitions, see FM 100-10.

■ 197. **NATURE OF SUPPLIES.**—*a.* The Corps of Engineers is specifically charged within any theater of operations with procurement, storage, and issue of all engineer equipment, materials, and supplies required for use of engineer troops or for troops of other arms and services.

b. Engineer supplies are officially enumerated in two lists known as the engineer procurement list and the engineer storage and issue list. The engineer procurement list and the corresponding lists of the other supply services do not directly concern officers in command of troops. The procurement lists merely effect a division of responsibility in the purchasing functions of the War Department and do not govern the responsibility of the supply services for supply of articles to troops.

■ 198. **SUPPLY ITEMS.**—*a. Engineer supplies.*—The organizational equipment of troops is in class II, while the bulk of construction materials is in class IV. (See FM 100-10.)

b. Troop equipment.—Standard items of engineer equipment are issued to troops of all arms and services in accordance with Tables of Equipment. These items are for the most part sets of equipment similar to those issued to engineer troops. (See Corps of Engineers Supply Catalog.)

c. Supply items in division.—In addition to troop equipment, engineer supplies used in the division vary considerably in kind and quantity, depending upon the character

of operations. Principal requirements may be summed up as construction materials for organization of the ground and for obstacles, camouflage material, materials for road building and maintenance, river-crossing material, demolition equipment and supplies, and water-supply equipment.

(1) *Fortification supplies.*—Materials required for organization of the ground include trench revetment such as sandbags, wire netting, corrugated iron, expanded metal, brushwood, and poles; trench boards; A-frames; trench pumps; materials for construction of dugouts and mine galleries; and materials for construction of obstacles such as barbed wire and pickets.

(2) *Camouflage supplies.*—Some of the more important articles of camouflage supplies are osnaburg (or burlap), cotton cloth, camouflage nets, paints, pain-spraying machines, chicken wire, and smooth wire rolls.

(3) *Road materials.*—Materials for road repair consist principally of crushed rock, gravel, and plank obtained locally whenever possible. Equipment carried by division engineer units for road work and local development of road supplies includes tractors and air compressors. Heavier road equipment is obtained from rear echelons.

(4) *River-crossing material.*—Infantry support rafts and floating bridge equipage are carried by ponton units. Combat units carry pneumatic floats, assault boats, and reconnaissance boats. Bridge material placed in dumps consist principally of bridge timbers, bolts, and light portable bridges to assist artillery over rough ground. All kinds of bridge material and equipage are carried in engineer depots.

(5) *Demolition material.*—This consists of high explosives, caps, fuzes, and accessories, carried in limited quantities by engineer units. Additional quantities of high explosives may be obtained from higher echelons, army depots, or railheads.

d. Supply items in higher echelons.—Engineer supplies required by units in echelons higher than the division consist in general of camouflage, fortification, and construction material, the last constituting the largest portion of engineer supplies.

■ 199. *SUPPLY PLAN.*—*a.* Any military unit, large or small, must carry supplies into the field and be prepared to replen-

ish and supplement them as the need arises. The supply plan must fit the tactical situation and cover both supplies to be carried and arrangements for resupply.

b. The use of large armored and air forces in modern war has increased the need in military units for a high degree of self-containment and mobility. Hence the supply plan of a unit is necessarily a compromise. The object of supply planning is to have each unit carry only those supplies essential for immediate use, while providing in successive echelons to the rear only the minimum stores and transport necessary to replenish and supplement unit supplies. A command decision as to the kind and amount of supplies to be carried and the method and frequency of replenishment must be made after a careful study of the military situation.

■ 200. RESERVES.—a. If it were possible to anticipate in advance all unusual needs for supplies and if lines of communication could be counted on to function without interruption, a single base of resupply for a large unit would be sufficient. However, terrain and weather, as well as enemy action, must be expected to create unpredictable demands on the supply system and break-downs in communication. To enable the supply system to function under unfavorable conditions, reserves are necessary in the successive echelons. Thus the high-explosive supply in the squad demolition set can be replenished from reserves in the platoon and higher echelons.

b. The amount of reserve in each echelon and the frequency of replenishment vary with the type of supplies as well as with the tactical operation engaged in. Reserves and deliveries cannot be constant for such items of supply as ammunition and fortification material since their rate of consumption fluctuates. Size of reserves depends on the situation and at times emergency demands will require supply from rear echelons.

■ 201. LOCAL PROCUREMENT.—Local resources should be utilized to the utmost for supplies such as engineer construction material. This practice reduces the load on communication and increases the mobility of troops. The procedure to be followed in procurement is a command decision of the theater commander.

■ 202. **SIMPLICITY.**—Simplicity in supply is vital. The commander of a small engineer unit must prepare plans for road and bridge repairing, fortification work, or building construction so as to keep to a minimum the kinds and quantity of materials and additional equipment required. In combat operations, individual equipment should be cut to the minimum. Conveniences may be furnished during rest and recuperation; but active modern mechanized war demands that transport space be devoted to carrying only necessary materials. Frugality and endurance on the part of officers and men are necessary to obtain mobility.

■ 203. **RESPONSIBILITY.**—The impetus of supply is from rear to front. It is the function of each element in the supply chain to push supplies forward to elements in front. Each commander is responsible, however, for making his requirements known to higher authority and for arranging to draw and distribute supplies allocated to him. Careful advance planning and timely notification of requirements are necessary so that supplies may be received when needed.

SECTION II

ORGANIZATION, PROCEDURES, AND REQUIREMENTS

■ 204. **SUPPLY RESPONSIBILITIES OF UNIT ENGINEERS.**—Under each unit engineer within the theater of operations, agencies are provided whose primary duty is to provide the troops of that unit with engineer equipment, material, and supplies. These supply agencies vary from a limited personnel with a small amount of mobile supplies within the division to extensive depot and supply organizations in the army and communications zone. Figure 31 shows the routing of requisitions and flow of supplies.

■ 205. **PLANNING AND SUPERVISION.**—*a.* In every new situation a careful estimate of the engineer supply situation is made by the unit engineer and his staff. They consider present and prospective operations, the general plan for the supply of the unit, probable demands for supplies, available transportation, and the time element.

b. A plan of engineer supply is drawn up and submitted

for approval to G-4 of the unit, after which it may be published in orders. It sets forth the location of engineer supply points, character of items to be supplied, troops to be engaged

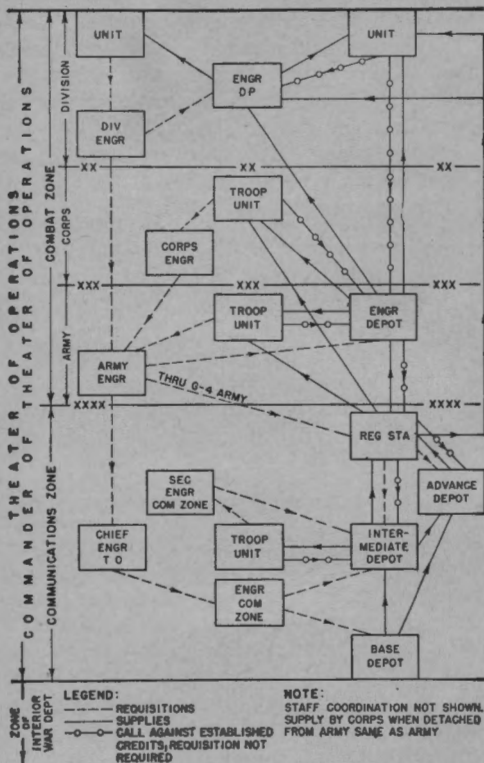


FIGURE 31.—Normal routing of requisitions and forwarding of engineer supplies in theater of operations.

in engineer supply, and transportation to be allotted to supply agencies for movements of supplies.

c. Time for necessary preparations must be available to carry out the supply plan successfully. Preparations include assembly and inventory of stocks locally available, procure-

ment and transportation of stocks from engineer supply points in the rear, and placing of supplies near points of probable use.

d. The operation of the supply system must be carefully supervised by the supply officer on the staff of each unit engineer. Supply officers of the several echelons maintain liaison among themselves for mutual assistance in making maximum use of available supply stocks.

■ 206. SUPPLY AGENCIES IN HEADQUARTERS THEATER OF OPERATIONS.—a. The supply section of the office of the chief engineer, theater of operations, is an organization for control and planning. Supply operations are handled by engineers of the communications zone and of the armies. This supply section is concerned with determining requirements in engineer supply, with policies and priorities, and with allocating equipment, materials, and supplies between the several armies and the communications zone. These activities are governed by the general arrangements, policies, and directives of G-4. The functions of procurement, storage, and issue of engineer supplies are the responsibility of the communications zone engineer.

b. Generally the supply section, office of the chief engineer, is organized into five branches: requirements; procurement; storage and issue; supply-information; and engineering, development, and specifications.

(1) The *requirements branch* is responsible for estimating all requirements sufficiently in advance and with sufficient factors of safety to insure that needs will be met. It establishes credits at depots and approves such requisitions as must be submitted directly to the chief engineer, theater of operations.

(2) The *procurement branch* supervises purchasing within the theater of operations.

(3) The *storage and issue branch* supervises the depot system of the entire theater.

(4) The *supply-information branch* maintains and furnishes statistics concerning purchase and delivery of equipment.

(5) The *engineering, development, and specifications branch* investigates, designs, develops, and prepares necessary

specifications and drawings for all items of military engineer equipment.

■ 207. COMMUNICATIONS ZONE.—a. The supply section, office of the engineer, communications zone, is an operating agency. It exercises general control over supply activities of engineers in the communications zone and maintains close liaison with the corresponding subdivisions of the chief engineer, theater of operations.

b. Replenishment of all depot stocks both in the combat zone and in the communications zone as approved by the engineer, theater of operations, is the direct responsibility of the engineer, communications zone. If the communications zone is divided into sections, engineer depots and port supply activities may be operated directly under the section engineers within whose sections they lie. The supply officers of troops engaged in engineer work under a section engineer either submit requisitions to him or call directly at the nearest depot where they have been allotted credits.

c. The supply section, office of the engineer, communications zone, generally is organized into three branches: requirements, procurements, and storage and issue.

(1) The *requirements branch* is responsible for estimating the needs of all engineer troops and projects in the communications zone far enough in advance so that ample stocks can be built up in depots for issue when needed. It acts upon requisitions from the field, routing them to the storage and issue branch when stocks are on hand or expected. If the supplies requested are not on hand, on order, or en route, the requirements branch makes requisition, through the chief engineer, upon the zone of interior, unless the supplies can be purchased within the theater of operation.

(2) The *procurement branch* makes purchases of supplies in the theater of operations in accordance with the procurement schedule furnished by the requirements branch.

(3) The *storage and issue branch* is responsible for storage and issue of supplies upon requisitions from the field. Issue of supplies is made either on requisitions approved by the engineer, communications zone, or against credits established by authority of the engineer, communications zone.

d. Engineer depot companies furnish both office and outside organizations for depot operations. Water-supply and topographic battalions supply water and maps.

■ 208. ARMY.—*a.* The army engineer is responsible for the distribution of engineer supplies to all troops of the army. The corps does not conduct supply operation; therefore both divisions and corps troops, as well as army troops, are supplied directly from army supply points. The transportation and supply section, army engineer headquarters, recommends the stocks to be established in army depots and credits to be established in depots in the communications zone. It acts on requisitions of lower units and forwards them to army depots; or it consolidates and forwards them through G-4, army, to depots in the communications zone. Engineer supplies for the army are shipped from depots through the regulating officer to army engineer supply points. The supply section assists the army engineer in supervising the supply of corps and army troops and in insuring an adequate supply plan. It supervises the establishment, operation, and displacement of army supply agencies.

b. The army engineer normally has under his command several supply agencies. As in the communications zone, water-supply battalions assist in the supply of water, topographic battalions assist in the supply of maps, and depot companies establish depots for issuing all engineer supplies. When army supply activities are extensive, general engineer units may be assigned to assist or supplement other supply agencies.

■ 209. CORPS.—*a.* In general the corps engineer is responsible for distributing engineer supplies to corps troops only. He also exercises general supervision over supply to divisions and assures himself that such supply is adequate. He makes provision for relieving divisions of the care of accumulated materials.

b. When the corps is detached from the army, in supplying the divisions of the corps, the corps engineer performs duties similar to those of an army engineer. In this case, personnel for operating corps engineer supply establishments may consist of depot companies attached by a higher echelon for the purpose or may be general engineer troops.

c. Normally, a corps engineer unit establishes only such supply points as are necessary for its own use, and all corps troops draw engineer supplies directly from supply points established by the field army within the corps service area. Exceptions to this practice apply to water and maps. Corps engineers establish water points necessary for supply of all corps troops and procure, reproduce, and distribute maps both to corps troops and to the divisions in the corps. Corps engineer supply points are located and operated like division engineer supply points.

■ 210. DIVISION.—*a. General.*—(1) The division engineer exercises his function as engineer supply officer chiefly through the supply officer (S-4) of the division engineer unit. A small reserve of engineer materials and supplies is carried in the transportation assigned to the engineer battalion.

(2) Supply activities of division engineers include establishment and operation of engineer dumps, distributing points, and water-supply points.

b. Personnel employed.—S-4 of the engineer battalion is assisted in supply operations by a supply section consisting of personnel from the headquarters and service company. This personnel includes a battalion supply sergeant, storekeepers, clerks, and other enlisted men, who assist in supply planning and supply operations. In most division engineer units, water-supply personnel is assigned to the supply section. Additional personnel from the headquarters and service company normally are engaged in supply operations under the supervision of S-4. Personnel of the lettered companies also furnish assistance when necessary, usually by constructing access roads or other facilities for supply points or by moving large stocks of bulky items.

c. Engineer supply points.—(1) At least one engineer supply point is always operated for a division. Normally, a single engineer supply point is sufficient for a division, but in defense, in a rapid advance, when the division is operating on a wide front, or when the road net is poor or congested, more than one supply point may be necessary. In such cases, besides a principal supply point, secondary supply points with limited stocks are established to meet the needs of sub-

ordinate units or subdivisions of the division area. Often it will be necessary to have mobile supply points to furnish rapidly items such as bridge timbers and balk. At these points the trucks are kept loaded with standard loads ready to move out promptly.

(2) The principal engineer division supply point is located beyond medium range of enemy artillery. It must be easily accessible from the main supply road and should preferably be near it. A central location is desirable. When the division is in bivouac, the principal supply point is located near the bivouac of the headquarters and service company. It should always be located where concealment from air observation is possible and advantage should be taken of natural obstacles against armored vehicles. Stocks should be camouflaged and dispersed. When the division is on the march, the principal engineer supply point may move in two echelons, so as to open in a new location before closing in the old one. Sometimes it may displace in one echelon; in such a case the supply point consists of the vehicles transporting the supplies.

(3) The principal engineer supply point for a division is normally operated by at least one noncommissioned officer and several privates. Usually this is not sufficient to load vehicles. When the situation is such that frequent issues of heavy materials are required, the operating personnel must be strengthened. The supply point is stocked initially with the equipment and supplies normally carried by the headquarters and service company for battalion and division use. Additional stocks are obtained from army depots and local sources, using transportation released when normal loads are dumped. Types and quantities of supplies thus added vary widely and should be determined by the commander as a result of his supply estimate. When the transportation available to the supply officer is more than sufficient to maintain necessary stocks of engineer supplies, it is employed to transport supplies to the using units.

(4) Secondary engineer supply points may be established anywhere within the division area. Cover, concealment, and easy access are desirable characteristics. These may

consist of dumps of road metal and bridge timbers spotted for the immediate repair of roads or bridges expected to be damaged by the enemy, or of small distributing points similar to the principal engineer supply point. The minimum operating personnel for 24 hours for such a point is one noncommissioned officer and two men. Stocks of engineer supplies, such as lumber and road materials, found in the area are reported to S-4. They are used to increase the stocks of supply points or are distributed from secondary supply points set up on the spot.

d. Issue of supplies.—Issues of expendable supplies from division distributing points usually are made to troops upon a statement from the commander who draws them that they are necessary. Nonexpendable supplies are issued in accordance with approved requisitions or established credit. A running account of stock is kept and studied to determine what items are being expended most rapidly. An orderly arrangement of stocks is maintained to promote efficient operation.

e. Other supply points.—Water-supply points are established by army units as described in paragraph 219. A single map-supply point normally is established at army headquarters, the principal army depot, or at the topographic battalion headquarters. A distribution point for camouflage supplies may be established by the camouflage battalion. In some cases general engineer units may operate distributing points for road metal, or forestry companies as distributing points for lumber. Dumps of road and bridge materials may be established in corps and army service areas conveniently located for use.

■ 211. SUPPLY IN OFFENSIVE.—*a. Items.*—In the offensive, the principal items of engineer supply consist of materials for repair and maintenance of routes of communication. Road metal is required in large quantities. It is procured from local quarries, if possible, and is placed along the roads most vital to the operation. Road plank is concentrated at dumps for use in making turnouts around craters. Bridge timbers are located near bridges which may be destroyed by enemy fire or which need to be strengthened for heavy loads. Explosives may be required in large quantities for destruction of enemy obstacles.

b. Operations.—As the attack progresses, dumps are advanced. Captured supplies and local resources, such as rock quarries and standing timber, are exploited to the utmost. This calls for active and persistent engineer reconnaissance of captured ground. As the divisions advance, army engineers, utilizing personnel of depot companies, take over operation of engineer dumps which the divisions relinquish. They may assist division engineers by sending transportation and personnel for supply operations and by advancing materials to new dumps in captured territory. The engineers of all echelons prepare plans of supply for the attack and for meeting a new situation such as organization of a defensive position, renewal of the attack, pursuit, withdrawal, or retirement. This generally involves only planning, as the physical accumulation of excessive stocks must be avoided.

■ 212. SUPPLY IN PURSUIT OR RAPID MOVEMENT.—The location of rapidly moving columns must be determined in advance if supply is to be maintained. This is difficult and requires exacting staff work. Engineers must accompany such columns with carefully selected engineer supplies. Local materials and abandoned enemy supplies must be exploited to the utmost.

■ 213. SUPPLY IN DEFENSE.—*a.* In the defensive fortification supplies must reach the troops promptly. Engineer distributing points are established where supplies are delivered to using troops. Tools and supplies may be delivered directly to the battalion sectors. Supply of materials for fortification work is described in chapter 7. An engineer distributing point is usually established in the vicinity of the engineer bivouac area, stocked with supplies dumped by trucks of the divisional engineer unit. These include fortification materials, camouflage materials, and road plank. Other similar dumps and distributing points may be established in rear areas.

b. Large quantities of road and camouflage materials are required. Road materials, except plank, usually are placed in separate dumps. Road plank is stored at dumps of general supplies. Bridge timbers or prefabricated bridges may be located near the sites of important bridges which are subject to destruction.

■ **214. SUPPLY IN WITHDRAWAL OR RETIREMENT.**—*a.* In a retirement, the troops continually move toward supplies previously concentrated. The principal supplies required are for demolitions and organization of selected defensive positions. The most difficult problem is to evacuate supplies to the rear. If a retrograde movement is possible or expected, supplies may be held on vehicles rather than placed in depots or dumps.

b. Once the decision to withdraw has been reached, the supplies brought into the area are held to the minimum and every effort is made to use forward stocks.

c. Removal or destruction of supplies must be accomplished with secrecy and the movements of trains must not interfere with movement of combat troops. All supplies must be used up, evacuated, or destroyed. Great care must be exercised in blowing up or burning dumps of supplies, since this is a strong indication to the enemy of a contemplated retirement. The decision to destroy or abandon supplies is made by the commander of troops in the area; a request for such a decision is made by the unit engineer early enough to accomplish destruction.

SECTION III

DEPOTS AND MAINTENANCE OF EQUIPMENT

■ **215. CLASSIFICATION OF DEPOTS.**—An engineer depot may be exclusively an engineer establishment, in which case it is called a special depot, or it may be an engineer section of a general depot which carries stocks of more than one supply arm or service.

■ **216. GENERAL DEPOT.**—In a general depot, an officer is designated as engineer supply officer. He has charge of the proper storage, care, maintenance, and issue of all engineer supplies, equipment, and material under such instructions as may be prescribed by the engineer of the communications zone. He controls the necessary technical personnel handling engineer supplies and records. He supervises loading and unloading of engineer supplies, proper marking of shipments, and transmission of information about shipments to consignees. He arranges for transportation only through duly constituted transportation agencies, under supervision of the commanding officer of the general depot.

■ 217. ADVANCE SUPPLY DEPOTS.—*a. General.*—(1) Engineer supply depots in the advance section of the communications zone are much smaller than those in the base or intermediate sections. They are located about 6 to 8 hours' freight haul from the railheads. They carry common engineer supplies and technical equipment for combat engineer troops. The



FIGURE 32.—Typical lay-out of advanced engineer depot in communications zone.

supply sections are less numerous than in the organization given in paragraph 207c, but they are organized on the same lines, two or more of the depot sections being combined into one at the advance depots.

(2) A schematic diagram for an engineer supply depot of this type is shown in figure 32. This diagram must be modi-

fied as necessary to conform to existing terrain and communication facilities, type of operations to be expected (and hence stockage to be maintained), and other considerations. The various parts of the depot should be dispersed at least as much as shown in figure 32, and every effort must be made to camouflage the installations.

b. Army depots.—(1) Army depots must be distributed in the army and corps service areas so as to permit easy and speedy transport and distribution of necessary engineer supplies. Normally, the minimum requirement is one depot in the rear portion of the army service area and a smaller depot or distributing point either in the rear part of the service area of each corps or in the forward part of the army service area behind each corps.

(2) An army depot should be located on a railroad in an area which affords concealment from aerial observation, room for dispersion of supplies, good access to the main road net, good drainage, and hard standing for vehicles. It should be far enough to the rear to be out of range of enemy artillery fire. Locations which take advantage of natural obstacles for protection against mechanized attack are preferable.

(3) Army engineer depots and distributing points are normally operated by depot companies. One depot company usually operates not more than four depots. In such case the company headquarters operates a central depot which serves smaller depots established by the three platoons. When necessary, general engineer troops and dump truck companies may assist in the movement, establishment, and operation of army depots and distributing points. Supplies are issued by depots in accordance with requisitions or credits approved by army engineer headquarters. In emergencies, supplies not specifically reserved for other units are issued to troops without formality. Details for loading trucks are usually furnished by the units calling for supplies or from general engineer units. Transportation for delivery of engineer supplies is not available in depot companies but in some cases may be provided by other army troop units.

■ 218. MAINTENANCE OF ENGINEER EQUIPMENT.—Maintenance operations are coordinated with supply operations in order

to reduce to a minimum the need for new equipment. In some cases, it is best to exchange unserviceable equipment for equipment held in depots which is in operating condition. In other cases, it may be better to have the equipment repaired and returned to its original organization. Engineer battalions and regiments are each supplied with a motorized shop for second-echelon maintenance of engineer equipment. Third-echelon maintenance is provided by maintenance companies which are assigned to the field army and the theater headquarters reserve. Maintenance companies make contact with units using engineer equipment, advise them as to the best methods of maintenance and of making second-echelon repairs, and execute repairs beyond the capabilities of the second-echelon maintenance elements. Fourth-echelon maintenance of engineer equipment is provided by engineer heavy shop companies, which are assigned to the communications zone. Equipment requiring repair by the engineer heavy shop company normally is exchanged for serviceable equipment through supply channels and is sent to the heavy shop company by the engineer depots of the communications zone.

SECTION IV

WATER SUPPLY

■ 219. *IN THE DIVISION.*—*a. Location and distribution of water points.*—All division engineer units are supplied with water purification equipment suitable for pumping, purifying, storing, and dispensing water secured from local sources. They utilize this equipment to set up and operate water-supply points for the division.

(1) Water-supply points are located whenever practicable near the kitchens of the principal elements of the division and are not normally within medium range of enemy artillery. A favorable location for a water-supply point should have an adequate supply of water which can be made potable with the equipment available, good overhead concealment, and suitable access routes to the main road net.

(2) Convenient water-supply points should be provided for all of the principal elements of the division. Within an infantry division, two water-supply points are normally suf-

ficient to provide the necessary quantity of water and to allow adequate distribution. When the division is operating on a wide front or when the road net is inadequate or congested, it may be necessary to operate more than two. Water-supply equipment not in use is kept in reserve and may be used to open water-supply points in new areas before closing the old ones.

(3) When local sources of water are exceptionally plentiful and of high quality, troop units of all arms and services may obtain their water directly from local sources, sterilizing it themselves without the use of engineer equipment. All such water sources, however, must be checked by a medical officer before use.

b. Operation of water-supply points.—(1) S-4 of engineer units acts as water-supply officer. He supervises the personnel provided specifically for the operation of water-supply points. Although this personnel is sufficient for routine operation, additional personnel normally must be provided for construction of water-supply points and access roads, and, in some cases, for traffic control. Construction is usually executed by the lettered companies.

(2) Normally, water is supplied at any water-supply point to all units requesting it and in any desired quantity. Sufficient personnel is provided to operate the equipment, make simple tests of its quality, prevent waste and contamination, and enforce camouflage and traffic discipline.

(3) When local sources of water are not available within the division area, water for the operation of supply points set up by the division engineers is brought forward by transportation of the water supply battalion of the field army. In desert warfare or where supply of water is difficult, its distribution may be restricted and a simple method of accounting set up.

■ 220. IN CORPS SERVICE AREA.—General engineer units assigned to the corps have water-supply equipment and personnel similar to those assigned division engineer units. Corps troops are supplied with water at distributing points established by the corps engineers.

■ 221. IN ARMY AREA.—*a.* A water supply battalion is assigned to each field army. This unit establishes water-

supply points for serving troops in the army service area and transports water, when necessary, to the water-supply points established by corps and division engineers. It is equipped with storage tanks, tank trucks, water-purification equipment of higher capacity than that issued to general engineer units, and well-drilling equipment.

b. In cases where water is not available from local sources in the army service area, it may be transported from the communications zone by tank trucks, railroad tankcars, ships, or barges. It is distributed to water-supply points by the tank trucks of the water-supply battalion.

c. Other engineer units assigned to the field army have small water-purification sets similar to those assigned to divisions; water-supply points established by these units are intended primarily for their own use but may frequently serve other nearby units. Water-supply installations in the army service area are constructed by general engineer troops.

■ 222. IN COMMUNICATIONS ZONE.—In the communications zone, demands for water may be enormous. Some of the usual needs are for operation of steam power plants of all kinds, operation of railroads, supply of large cantonments, and water supply for concrete construction and water-bound macadam roads. Where local resources are deficient, water to meet these needs is transported by rail, boat, or pipe line.

a. The section engineer is charged with the development and operation of water supply in this section. His activities may include—

(1) Operating existing plants and installations.

(2) Constructing and operating reservoirs, dams, stand-pipes, pumping stations, filter beds, sterilization devices, pipe lines, and other means of purification and distribution.

b. The general considerations which apply to other construction activities in the section apply to water-supply activities. Responsibility for construction and operation rests with the section commander; the construction is executed in accordance with policies laid down and projects approved by the headquarters of the theater of operations.

■ 223. WATER-SUPPLY ACTIVITIES OF CHIEF ENGINEER.—Water-supply policies promulgated by the staff at task headquarters are based on recommendations of the chief engineer. Proj-

ects for major water-supply construction submitted by the engineer of the communications zone are technically scrutinized, and the chief engineer at task headquarters recommends their approval or modification. The chief engineer recommends the allocation of water-supply battalions from the task headquarters reserve to the several armies or sections, where required. He provides for depot storage and determines priorities of issue of water-supply equipment to meet prospective operations. The intelligence officer on the staff of the chief engineer collects and compiles, from all sources of information, data as to water resources in enemy territory, including results of geological investigations.

SECTION V

MAP SUPPLY

■ 224. **FUNDAMENTALS.**—*a.* Adequate supply of the best available maps is essential to efficient military operations. The theater commander prescribes the allowances of maps in the theater. Coordination of map-making and map-supply agencies of the forces is a vital command function.

b. Where suitable maps for military purposes do not exist, the aerial photograph in its various forms, especially the photomap, is used as a substitute. The aerial photograph not only serves as a map but as a means of producing maps by photographic methods. Where suitable maps are available, the aerial photograph is used to supplement the information on the map.

c. Once initial allowances of existing military maps have been made, difficulties of production and distribution, as well as the weights involved, necessitate economy in map issues. Supply of maps and aerial photographs requires continuous coordination and supervision of procurement and distribution.

d. Decentralization of production, reproduction, and distribution is necessary. Means are provided in appropriate echelons for procuring photographs, making maps, and producing and distributing both in quantity.

■ 225. **MILITARY MAPPING AND SUPPLY MISSION.**—Because of lack of suitable topographic maps of the United States as well as of other parts of the world, the army as it moves in

the theater of operations must be prepared to produce maps adequate for minimum military requirements. The Corps of Engineers and the Army Air Forces are trained and equipped to provide the necessary maps in the field. Classification of military maps as to purpose, characteristics, use, types, preparation, scales, etc., is covered in FM 30-20 and in AR 300-15.

■ 226. RESPONSIBILITY FOR MAP SUPPLY AND DISTRIBUTION.—*a.* The Chief of Engineers, under policies prescribed by the assistant chief of staff, G-2, is charged with all military mapping in the zone of the interior and with the preparation or procurement of such maps of foreign territory as may be prescribed by the Secretary of War. He is responsible for the supply of maps needed for training proposed by authorized organizations and individuals in the military service. He prepares the initial supply of maps for any new theater of operations.

b. The Corps of Engineers and the Army Air Forces are charged jointly with preparation of all maps requiring use of aerial photographs.

c. The Army Air Forces are charged with aerial photographic work for military mapping operations in accordance with specifications prepared by the Corps of Engineers.

d. (1) The Corps of Engineers is charged with preparation of maps and map substitutes from aerial photographs, with prosecution of surveys, with compilations for production or revision of maps, and with their production, reproduction, supply, and distribution.

(2) Maps are class IV supplies and are furnished on requisition in the same manner as other engineer class IV supplies.

e. In a theater of operations, coordination of map-making and supply agencies is a function of command.

(1) Unit engineers of the various echelons of command (tasks headquarters, air force, army, corps, and division) are responsible for the preparation or procurement, production, reproduction, supply, and distribution, under approved policies of the various commanders and under direct supervision of the various commanders and under direct supervision of the various assistant chiefs of staff, G-2, of all maps required by their units for operations.

(2) Topographic units are under control of the respective unit engineers. Within the limits and capabilities of his equipment and personnel and under the supervision of the unit G-2, the unit engineer (operating through his S-2) is charged with the following duties:

(a) Requisition of necessary maps obtainable from higher echelon.

(b) Preparation of maps and charts required for his unit which are not obtainable from higher echelon.

(c) Liaison with Army Air Forces to obtain photographs for making maps or map substitutes.

(d) Preparation of plans for mapping missions, with priorities in accordance with tactical situation and policies of unit commander.

(e) Reproduction of maps, sketches, overlays, graphical data, and aerial photographs, as necessary.

(f) Preparation of a table of map allowances, in accordance with established policies.

(g) Distribution of military maps, except such confidential or secret maps as may require special distribution.

f. Table VI shows the channels for supply and distribution.

■ 227. INITIAL ALLOWANCES OF EXISTING MAPS.—a. Map allowances are based on the principle that individuals or organizations should have an adequate supply of maps of areas in which they are operating, or in which they have an immediate prospective interest. Units should not be burdened with maps of areas outside their zone of operations. The allowances prescribed are sufficient for minimum needs only. Intervening headquarters not specifically authorized to stock maps do not retain copies but distribute those received directly to front-line units. The normal initial allowance of military maps is shown in FM 30-20.

b. (1) If maps of any of the standard scale groupings are not available, substitution of the same number of maps of the nearest scale is authorized.

(2) Special maps and road maps are issued as directed by the commanding officer.

c. The theater commander is authorized to change the initial allowance for maps and to prescribe the initial and replacement allowance for maps and aerial photographs for his theater of operations.

TABLE VI.—*Channels for map supply and distribution*

Organization or unit	Agency responsible for policies	Agency responsible for drawing and issuing	Agency from which secured	Remarks
THQ and THQ troops.	G-2, THQ	Chief Engineer, THQ ¹	War Department, GHQ topographical battalion ¹ and base plants. ¹	G-2 supplies the headquarters.
Army	G-2, army	Army engineer ¹	Army topographical battalion ¹ and engineer GHQ. ¹	Do.
Corps	G-2, corps	Corps engineer ¹	Corps topographical company ¹ and army engineer. ¹	Do.
Division	G-2, division	Division engineer ¹	Corps engineer ¹	Do.

¹ Only these agencies are authorized to maintain stocks of maps.

■ 228. ALLOWANCES OF MAPS PRODUCED IN THE FIELD.—The allowances of maps produced in the field in time of war are to be prescribed for each theater of operations by the theater commander.

■ 229. DISPOSITION WHEN TROOPS LEAVE AREA.—Whenever a tactical organization is relieved, the commanding officer in the area is responsible that all maps and map substitutes are collected and turned over to the commanding officer of the relieving unit or, if not replaced by troops, to the engineer of the territorial command, who causes all unserviceable copies to be destroyed under the personal supervision of an officer. Particular care must be taken to insure that no maps or map substitutes are abandoned.

CHAPTER 11

OPERATIONS OF DIVISION ENGINEER UNITS

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SECTION I

GENERAL

■ 230. SCOPE.—This chapter covers operations peculiar to division engineer units. Section I treats the subject generally and the remaining sections give information concerning a particular type of division engineer unit.

■ 231. ADVANCE.—*a. Duties.*—In an advance engineers may—

- (1) Execute reconnaissance.
- (2) Collect data for improvement of existing maps.
- (3) Remove obstructions on roads, including mines and traps.
- (4) Repair, extend, and improve routes of communication.
- (5) Facilitate passage of waterways by improving fords, by strengthening, repairing, or constructing bridges; and by installing and operating ferries.
- (6) Recommend a plan for traffic circulation.
- (7) Create demolitions and obstructions to prevent enemy interference on flanks and rear.

b. Preliminary operations.—The advance of the division must be preceded by thorough engineer reconnaissance and by such engineer work as may be necessary to prevent delays.

(1) Information obtained by engineer reconnaissance forms the basis for the unit engineer's recommendations and aids in the selection of suitable routes for march groups and the assignment of zones to columns. This reconnaissance also furnishes information for the selection of barriers to protect the march objective or to protect an open flank. It also locates supplies of engineer materials for necessary

engineer work prior to and during the march and in new assembly areas.

(2) Reconnaissance ahead of the main body of the division usually is conducted in areas where enemy mechanized patrols may be encountered. In this situation, engineer reconnaissance parties must operate as described in chapter 4. This slows up the rate at which reconnaissance can be made and increases the number of parties required to reconnoiter the assigned areas rapidly. Usually two or more parties from each lettered company are required for rapid reconnaissance of a division zone of advance.

(3) When reconnaissance shows that improvement of routes is necessary, the engineer work required is initiated promptly, and if possible, completed before the advance of the division. Engineers are provided near the head of each column to deal with unforeseen obstacles.

(4) An important engineer duty prior to the advance is to furnish signs for marking routes. The extent to which this is done varies with the situation. Column commanders normally employ troops of other arms to act as route markers.

c. Dispositions.—(1) The disposition of the engineer battalion in the advance must provide for a high degree of decentralization of command, with engineers attached to various components of the division. Engineers normally must be attached to the covering force; to the flank guard; and to each major march group, except in cases where one march group follows another on the same route. In making such attachments, advantage should be taken of the normal association of engineer companies with their corresponding infantry regiments in combat teams. Unnecessary dispersion of companies should be avoided. Unity of command within the engineer component of each security force or march group should be provided.

(2) Since engineers supporting the various elements of the division are in most cases attached, and therefore not available for quick withdrawal, it is necessary that the division engineer maintain a strong engineer reserve for handling unforeseen contingencies. Usually this is not less than one company and may be as much as two companies. The division engineer during a march dispatches engineers under

his control to any part of the division area where they may be required.

d. Engineers with advance guard.—Each column commander to whom engineers have been attached assigns some engineer elements to the advance guard. The commander of this engineer element functions as unit engineer of the advance guard and advises the advance guard commander as to the employment of engineer troops.

(1) Engineer reconnaissance parties should move with the most advanced elements of the advance guard to give timely warning of engineer work required.

(2) The main body of engineers attached to the advance guard moves with the support or reserve. It is not separated from its tools, transportation, and equipment. When the infantry component of an advance guard moves on foot, the main body of the engineer component moves by bounds in its vehicles in the gap between the support and the reserve or between the reserve and the main body. The advance guard engineers leave work details at vital points where need for engineer assistance exists or can be foreseen. These details rejoin their unit on completing their task. The advance guard engineers may thus become depleted and by the end of the march may be strung out at a number of points. It may be necessary, therefore, to renew their strength by attaching a new unit during the march.

e. Supply.—(1) Engineer supplies in the advance normally are provided from stocks of materials carried by the lettered companies and from the additional stocks carried by the headquarters and service company in its organic vehicles. In some cases, rear engineer supply points may be kept open during the advance in order to supply flank guards or forces in the rear areas. This is normal when the movement is executed by shuttling. New engineer supply points should be opened in the forward area as soon as practical.

(2) Rear water-supply points should be kept open long enough to permit all elements of the division to supply themselves before the movement. Water-supply points in the new area should be established immediately on arrival. Good water discipline is promoted if circumstances permit water-supply points to be opened in the new area before

arrival of the main body. Continuous service can be provided by sending forward some water-supply units to open in the new area, while others are kept in operation in the old areas until the last elements of the division leave.

■ 232. RETROGRADE MOVEMENTS.—*a. Duties.*—In a retrograde movement engineers may be employed as follows:

(1) Near heads of retiring columns on duties similar to those described in paragraph 231 for an advance.

(2) In denial operations.

(3) To delay enemy by destroying bridges, blocking roads, demolishing railways, and erecting barriers.

(4) To assist in hasty organization of the ground for delaying action.

(5) To assist in flank security by demolitions and obstacles.

(6) To participate in combat, especially in defense of road blocks and other obstacles.

b. Dispositions.—(1) It is vital in a retrograde movement that the head of the unit be kept moving to the rear and that enemy movement in pursuit be delayed. Decision as to where the bulk of the engineers are to be placed must be made in accordance with the situation. Important elements affecting this decision are condition of communication to the rear, suitability of terrain for delaying the enemy by use of obstacles, and amount of delay required. Where communication is difficult to maintain and can be readily disrupted at many points, most of the engineers are normally required at the head of the retiring columns and a small proportion of engineers is assigned to delay the enemy. Where communication is easy to maintain and many detours are available for use if main routes are blocked, most of the engineers usually are employed in creating obstacles, with only a small proportion facilitating the movement of our own troops.

(2) In retrograde movements, as in the advance, the division commander decentralizes authority in order to provide unified commands which can deal promptly with local emergencies. Engineer elements assisting units of other arms usually are attached; such attachments normally are made to each combat team or other march group, and to the flank guards, covering forces, and any rear guards operating di-

rectly under control of the division commander. The engineer component frequently must be subdivided to provide engineer attachments to advance and rear guards and to any covering shell elements detached from the march group.

(3) Some engineers are held under the direct control of the division engineer for work for the division as a whole and for use as a reserve. They may be employed on denial operations as described in section I, chapter 7. This work must be executed in such a manner as to maintain secrecy. Engineers under battalion control may also be employed to lay out a rear position as described in section II, chapter 7. Because of the great need for decentralization of engineer work in retrograde movements, the reserve kept by the division engineer under his own control generally is small.

c. Demolitions.—(1) Demolitions are particularly important in retrograde movements. Demolition charges may be placed by engineers accompanying the leading troops and may be executed by rear elements in accordance with orders of the division commander or of the commander of the rear-guard covering force or covering shell. In such cases a guard is left for each demolition to be executed. For disposition in defense of a prepared demolition site see paragraph 264. Liaison with friendly troops operating between the enemy and the prepared demolitions is necessary in order to preserve routes for the withdrawal of these troops. Demolitions are executed as early as possible consistent with such withdrawal. Demolitions must not be endangered by waiting for stragglers or small delayed bodies.

(2) Orders for the execution of demolitions must be definite and clear. They may be of any one of the following types, depending on the situation:

- (a) To be executed as soon as prepared.
- (b) To be executed at a stated time.
- (c) To be executed only when necessary to prevent site falling into hands of enemy.
- (d) To be executed only when ordered by a stated officer. In such case the official title and unit of officer authorized to give order must be given in writing. Means of communication for issuance of order must be provided.
- (e) To be executed only when ordered by a stated officer

or when necessary to prevent site falling into hands of enemy.

d. Supply.—In a retrograde movement, supply trains, including engineer supplies and equipment, are normally among the first elements to move to the rear. However, in order to meet the needs of engineers with security elements, it frequently may be necessary to operate engineer supply points near the front until the last elements withdraw.

■ **233. ATTACK.**—*a. Duties.*—In preparation for and during an attack engineers may be employed to—

- (1) Execute reconnaissance.
- (2) Maintain and improve roads and bridges for troop movement, supply, and evacuation.
- (3) Recommend a plan for traffic circulation.
- (4) Assist forward movement of infantry, artillery, and tanks by repairing roads, constructing bridges, and removing obstacles.
- (5) Locate, mark, and destroy mine fields and trap mines.
- (6) Destroy enemy emplacements with hand-placed explosive charges.
- (7) Assist in flank security through use of demolitions, mine fields, and obstacles.
- (8) Construct advance landing fields.
- (9) Accumulate stores of engineer material for use in attack and in consolidation of captured ground.
- (10) Locate, mark, and improve sources of water supply.
- (11) Assist in organization of captured ground; supply fortification materials to other troops.
- (12) Participate in combat.

b. Preliminary operations.—(1) During the preparatory stage before the attack, division engineer units—

(a) Engage in reconnaissance and obtain engineer information by all available means. Reconnaissance is conducted on foot by infantry and engineer patrols to secure information of enemy obstacles and dispositions. Such close-in reconnaissance normally is done at night, and engineer personnel must be specially trained for the task.

(b) Improve communication to increase traffic capacity and keep maintenance work at a minimum.

(c) Obtain and distribute maps and aerial photographs of area of advance.

(d) If time permits, rehearse units to be employed in removal of obstacles during the attack of organized localities and rehearse them with the units of other arms with which they are to operate.

(e) Collect engineer supplies needed in the attack, such as bridging equipment, road metal, bangalore torpedoes, and ammunition.

(f) Make sure that engineer measures likely to betray imminence of attack are carried out secretly or deferred as long as possible.

(g) Take over flank-barrier defense if necessary to relieve infantry for the attack.

(h) Prepare and defend additional obstacles to protect an open flank or cover a gap in the front, if necessary.

(2) During this preparatory stage, corps engineers will take over some of the tasks of division engineer units in order to release them for work further forward.

c. Assistance rendered infantry in attack.—(1) Sufficient engineer troops are never available to do all engineer work necessary to assist the advance of other arms, so they perform as much of this work as possible. The infantry does its own pioneer work and engineers assist them only when additional means are required. The infantry clears passages through wire, bridges narrow and shallow streams with logs or timber found locally, and uses other such expedients to the maximum degree. Infantry specially trained for the purpose may remove antitank and antipersonnel mines.

(2) In some cases, especially where antipersonnel mines and booby traps in large numbers are likely to be encountered, engineers are provided to assist the infantry advance. They may precede or accompany the most advanced infantry elements, in which case the engineers must move on foot. Engineer troops moving on foot with the infantry carry engineer tools and materials required for their engineer tasks. These supplies must be selected carefully and limited in weight so that they will not prevent keeping up with the infantry. Provisions must be made for bringing additional engineer supplies to points close behind the foremost element.

(3) Division engineer units usually assist the infantry by helping the forward displacement of infantry vehicles. This

work is limited to the minimum necessary to accomplish the task. For example, if an engineer platoon is assigned to an infantry battalion with 60 vehicles, just enough engineer work is done to provide for the movement of 60 vehicles. The attack is followed up by other engineers who make necessary additional improvements. An engineer unit assigned the task of supporting an infantry unit is also responsible for assisting the forward displacement of the artillery directly supporting it. The light artillery usually follows the routes used by the infantry vehicles. The medium artillery generally moves by the best routes.

NOTE.—Subparagraph *c* is applicable to dismounted cavalry as well as infantry.

d. Dispositions.—(1) In the attack, both organic division engineer units and those attached to the division normally are best employed under division control. In infantry and motorized divisions, engineers normally are attached to infantry units when the situation is such that the division commander is unable to exercise centralized control of supporting elements; when engineers must accompany leading infantry to assist in overcoming obstacles; or when an infantry unit is sent on a detached mission. In the cavalry, mountain, airborne, and armored divisions, attachment of engineers in the attack is more frequent because their operations are extended over broader areas and therefore must be more decentralized.

(2) Frequently in the attack, and occasionally in the defense, engineer units are placed *in support* of other elements of the division.

(a) An engineer unit assigned to support an infantry regiment is not placed under the infantry commander. The engineer unit remains under the division engineer, but must comply with all requests of the infantry commander for engineer work which can be executed with the means available whenever it does not conflict with the division engineer's orders. The engineer unit commander establishes liaison with the infantry commander in order to ascertain his requirements.

(b) A support assignment is a task assignment rather than an area assignment, but the supporting unit should conduct

engineer reconnaissance in the zone assigned to the supported unit. Normally it executes most of its work in that zone. In some cases the task assignment "to support" an infantry unit may be coupled with the area assignment "to do all necessary engineer work in the zone" of that unit. The support assignment may also be coupled with some other task assignment, such as the repair and maintenance of a section of the main supply road. When a conflict exists between the needs of a supported unit and the requirements of other tasks assigned an engineer unit in support, the engineer commander should immediately request a decision from the division engineer as to which is to be given priority. If at all practicable, priorities to cover such an eventuality should be established in advance, since all methods of communication are unreliable in battle.

(c) Engineers may be placed in support of artillery and other units as well as infantry. They are normally attached to, rather than placed in support of, tank units.

(3) In the attack, the division engineer should have at all times some engineer troops which he can use for unexpected missions. Ordinarily this reserve is not larger than a company and may consist of as little as a platoon. When a considerable proportion of the engineer strength is attached to units of other arms, the engineer reserve is stronger than where few attachments are made. The reserve is located so that the division engineer can dispatch units promptly to any place where need for their work exists. Wherever possible, the reserve is employed in executing engineer work of low priority and of such a nature that sudden interruptions will do no harm. The reserve can be rotated. Since a successful attack normally requires extensive engineer work, no engineer unit should be permitted to remain idle for as long as 24 hours.

(4) Engineers in an attack seldom are attached to, or placed in support of, infantry units in reserve.

(5) Engineers may be employed as an emergency reserve of infantry in the later stage of an attack.

(6) The command post of the division engineer unit is located near the division command post.

e. Supply.—The bulk of supplies required by engineers in

the attack normally consists of road and bridge materials. Requirements of these items are especially heavy when the attack moves rapidly over terrain which has been fought over for some time. Materials are concentrated well forward prior to the attack, and sources captured are sought out and exploited. Engineer platoons and companies following closely the advance of leading infantry elements carefully select supplies of road and bridge materials to be carried on organic transportation. Engineer supply points are displaced forward as rapidly as possible to reduce the hauling time for vehicles replenishing supplies. Water-supply points normally displace forward by night with the kitchen trains of the principal components of the division.

■ 234. PURSUIT.—The pursuit normally is conducted by direct pressure and by an encircling movement. A division in the pursuit may perform either or both of these actions.

a. Duties.—(1) Engineer reconnaissance is of primary importance in pursuit.

(2) Duties of divisional engineers with a direct-pressure force generally are similar to those in the attack. Passage of obstacles and hasty repairs to roads and bridges are of primary importance.

(3) Duties of division engineer units with an encircling force are generally similar to those of similar units in an advance. Opportunity for prior reconnaissance and preliminary engineer work are, however, very limited. After capture of the encircling force's objective, duties of the engineer component may be similar to those of engineers in attack or defense, depending on the situation.

b. Dispositions.—Requirements for engineer work in pursuit are exceptionally heavy. Work in rear areas must be turned over to corps or army engineers or suspended entirely in order to permit maximum engineer assistance to forward elements. Engineer units assisting the encircling force should be attached; unity of command must be provided within the engineer component. Engineer units assisting the direct-pressure force frequently may operate initially under direct control of the division engineers and later be attached to infantry elements, if failure of communication and discontinuity of the front make decentralization neces-

sary. The reserve of engineers kept under unit control is small in the pursuit and may even be completely eliminated.

c. Supply.—Supplies available to engineers in the pursuit frequently consist only of those carried with them or captured. Lettered companies may be reinforced with transportation and equipment (including water-supply units) from the headquarters and service company and with quartermaster transportation carrying additional engineer supplies.

■ 235. DEFENSE.—*a. Duties.*—In defensive situations engineers ordinarily are required to—

- (1) Execute reconnaissance.
- (2) Establish distributing points for supply of engineer material.
- (3) Repair, maintain, and improve roads for supply and evacuation, and prepare a plan for traffic circulation.
- (4) Assist in organization of the ground by executing works of a special character, such as demolitions, obstacles, and command and observation posts.
- (5) Assist in flank and rear-area security through use of demolitions and obstructions, and furnish materials to other units.
- (6) Improve facilities for water supply.
- (7) Provide camouflage material and give assistance in its use.
- (8) Supply maps.
- (9) Lay out rear defensive positions and switch positions.
- (10) Participate in combat.
- (11) Construct advanced landing fields.

b. Dispositions.—(1) In defensive operations, there normally is time for full coordination of the various elements of the division. Engineers usually are employed under the direct control of the division engineer. However, where the front defended is not continuous and the principal defensive elements are widely separated, as may be the case with mountain and motorized divisions, attachment of engineers in defense may be necessary.

(a) An engineer unit rendering direct assistance to a unit of another arm within or in rear of the main battle position is normally placed in support of it.

(b) The division in defense may organize a covering force or flank guard to make contact with the enemy and delay his advance at some distance from the battle position, beyond artillery range. Such forces usually have an engineer component which normally consists of an attached platoon or company; the duties of this engineer component are primarily concerned with the creation or improvement of obstacles to delay the enemy.

(c) The main line of resistance is usually covered by an outpost which is within supporting range of artillery occupying positions behind the main line of resistance. Engineers may assist the outpost troops in organization of their defensive positions, especially with regard to the creation of obstacles. Engineer units rendering such assistance normally are placed in support.

(d) Engineer bivouacs and principal supply installations are generally placed well to the rear in the defense, out of range of heavy artillery fire.

(2) During conduct of the defense, engineer units initially placed in support of, or attached to, units of other arms normally are withdrawn and assigned responsibility for all engineer work in subdivisions of the rear area. It is of paramount importance during this phase that engineers keep open all routes necessary for movement of reserves and ammunition. The engineer units, therefore, are distributed in the rear area in such a manner as to provide for prompt initiation of repairs to vital roads and bridges damaged by the enemy. Such distribution, in most cases, also facilitates the prompt employment of engineer troops to attack and destroy enemy airborne troops which may be landed behind the main battle position or to meet and delay mechanized raids in their initial stage.

(3) In the defense, more than in any other type of operation, engineers are required for combat action as a unit. Since they are normally widely distributed, it is usually necessary to designate a place and time for assembly for combat. The time allowed for assembly should be liberal.

(4) For operations of engineers in laying out and constructing defensive positions, see chapter 7.

c. Supply.—Generally the quantity of engineer supplies needed for the defense exceeds that for any other type of

operation. Fortification materials are provided in great quantities and must be distributed among many supply points. Materials for repair of roads and bridges are dumped throughout the rear area so as to provide for prompt initiation of repair work. For details of supply in the defense, see chapters 7 and 10.

■ **236. DEFENSE OF A RIVER LINE.—a. Duties.**—In the defense of a river line, engineer duties are similar to those given for the defense in paragraph 235. In addition, engineers may be required to—

(1) Execute terrain reconnaissance to discover possible hostile crossing fronts.

(2) Destroy boats, fords, bridges, and matériel which may assist the enemy in crossing.

(3) Block with obstacles and mines hostile avenues of approach to rivers, embarking points, and landing points.

(4) Prepare floating mines, rafts, and fireboats and hold them in readiness upstream.

(5) Make preparations for illuminating water areas at night.

(6) Maintain bridges or operate ferries for withdrawal of covering forces or for the entire division when it is defending a river front.

b. Dispositions.—(1) When the frontage defended by the division is narrow, engineers are best employed under engineer control.

(2) When the frontage defended is wide, the defense of the river normally is by defensive-offensive action, and holding forces may be required to defend one or more portions of the front while the bulk of the division is employed in counterattack elsewhere. If such action is probable, it frequently may be necessary to attach engineers to the holding forces in order to provide timely engineer assistance, well coordinated with the efforts of the holding force. The remainder of the engineers operate usually under division control.

■ **237. DEFENSE OF COAST LINE** (see FM 31-10).—The duties and dispositions of engineers in the defense of a coast line are similar to those in the defense of a river line. Reconnaissance of the water areas is necessary in addition to that

of the land areas. For water areas it is important that complete information be obtained as to the hydrographic characteristics, to include deep and shallow waters, reefs and shoals, rise and fall of tides, channels, and beach approaches. Other duties may include—

a. Maintenance of roads for movement of supplies and reserves.

b. Construction of railroads and sidings for use of railway artillery.

c. Construction of underwater obstacles and beach fortifications to block advance of amphibious tanks and troop-carrying barges and boats.

d. Demolition of landing facilities, such as piers and wharves.

e. Recommendations and advice on measures for deception and camouflage.

f. Removal of all road signs, if so directed, or alteration of them so as to deceive the enemy.

g. Blocking areas which might be used for landing troops by airplane and gliders.

■ 238. BIVOUAC.—a. *Duties*.—Engineers may be required to perform the following duties when the division bivouacs in a forward area:

(1) Execute general terrain reconnaissance.

(2) Repair existing routes to and within area.

(3) Provide additional access routes by construction of trails, fords, and small bridges.

(4) Assist in formulation of camouflage plans and in execution of camouflage measures.

(5) Assist in providing security for unit as a whole by preparation of road blocks and other obstructions and, in some cases, by providing outpost troops for their defense.

(6) Supply engineer materials and operate water-supply points.

b. *Dispositions*.—(1) When the division bivouacs, all engineers normally bivouac together and operate under unit control. Exceptions to this rule include those cases when engineer elements are attached to security forces, or when the bivouac is occupied for a short period prior to a continuation of the march or an attack conducted initially by combat

teams. In the latter case, engineer detachments bivouac with the combat teams or other groups to which they are attached.

(2) When the division bivouacs for rest after a march which is to be continued, the engineer command post and principal supply points are located near the bivouac of the battalion headquarters and service company. When the bivouac is occupied preparatory to combat, the engineer command post is located near the division command post and the supply point is located where it can best serve its purpose during combat.

c. Shelters in rear areas.—For a discussion of this subject, see chapter 8.

SECTION II

ENGINEER COMBAT BATTALION

■ 239. GENERAL.—The engineer combat battalion is the engineer component of the infantry division. It contains a headquarters, headquarters and service company, and three lettered companies. Each lettered company has three platoons of three squads each. The combat battalion has sufficient motor transportation to move all personnel simultaneously. Each squad with its tools and equipment is carried in a separate truck. For details of organization and duties, see FM 5-5.

■ 240. CONSIDERATIONS AFFECTING EMPLOYMENT.—*a. Combat teams.*—The principal combat elements of the infantry division are the three infantry regiments. Transportation of these regiments consists entirely of motor vehicles but is not sufficient for transporting personnel of the rifle companies. Each infantry regiment normally is associated with a light artillery battalion which is in support of it in attack and defense and is attached to it for marches. Supporting engineer and medical units, also, usually are attached to each infantry regiment for marches. The same units of supporting arms and services are habitually associated with the same infantry unit. The infantry regiment with associated supporting elements usually is referred to as a "combat team." In combat, the action of all the supporting arms and services normally is coordinated by the division commander.

b. Extent of division area.—An infantry division normally operates as part of a corps and has its flanks covered by

other divisions or by corps or army units. The front assigned an interior infantry division seldom exceeds 6 or 7 miles, except in the defense of a river or coast line. The rearward limit of responsibility of a front-line division for defense of rear areas and maintenance of communication normally is defined by a division rear boundary, which seldom is less than 5 miles or more than 20 miles from the front line.

c. Organic aviation.—The only aviation organically assigned to the division consists of light liaison-type airplanes for artillery observation.

■ 241. GENERAL EMPLOYMENT.—*a. Engineer component of combat teams.*—The engineer component of the combat team normally consists of one platoon. Each engineer platoon assigned to a combat team should be provided by a different company. Through continued association with the other combat team elements, the engineer platoon and the company of which it is a part becomes accustomed to methods of operation of that particular team and are thereby enabled to assist it more effectively. The company normally furnishing the engineer component of a combat team should furnish any additional attachments required, or should be assigned to support, when necessary, the same infantry regiment.

b. Dispositions of combat battalion for combat.—Dispositions are discussed in a general way in section I and in chapter 1.

(1) Because the infantry division operates in a relatively small area, and because development of combat action is limited by the speed of the foot soldier, the division commander normally is able to coordinate the combat action of the various elements of the division. Thus engineers are usually employed under control of the division engineer when the division engages in combat, and attachments of engineers for combat are exceptional. Combat teams usually are formed for marches only, attached units being released before entering combat. So that the division engineer may have sufficient information and control to render effective support to all elements of the division, engineer reconnaissance and engineer communication must be efficiently and energetically handled.

(2) In combat, the lettered companies frequently are ordered to support the infantry regiments with which they are normally associated. This assignment may be coupled with an order to do all necessary engineer work in the zone of the infantry regiment being supported. However in most cases, the division engineer does not assign work in such manner that every part of the division area has a particular engineer unit responsible for it. Parts of the division area may be assigned to specific engineer companies, while other parts are left unassigned and remain the direct responsibility of the division engineer. The division engineer may change initial assignments when new tasks arise, or use his reserves to meet demands for engineer work in unassigned areas.

(3) Maintenance of the main supply road must always be provided for. The amount of available engineer strength required for this task may vary from a very small force to nearly all the engineer troops.

(4) A reserve should always be provided. It is usually small (a platoon to a company) and is rotated when necessary so that all units are employed on engineer work to the limit of their capacity. The size of the reserve should be greatest in a rapidly-changing situation when most of the engineers assisting other units have been attached. The reserve should be centrally located and provided with rapid means of communication with the engineer command post.

c. Employment of attached units.—(1) The combat battalion is frequently reinforced by attachment of other engineer units. The units most frequently attached are ponton units and combat units of the corps. The attachment of six infantry support rafts from a ponton company is normal for many types of terrain. In some cases, engineer units attached to the division may not be attached to the combat battalion but may be employed on special tasks directly under division control. In such cases, the commander of the combat battalion remains the division engineer, even though the commander of the attached units is senior to him. When an engineer unit attached to a division is to be employed on work closely related to that of the combat battalion, it should be attached to the combat battalion and put under the command of the division engineer, even though the commander of the attached unit is senior to him.

(2) An engineer unit attached to a combat battalion should, so far as possible, be employed as a unit under its own commander. Normally such units are best employed on communication in the division rear area, the support of forward infantry and artillery units being furnished by engineers organically assigned to the division. However, in some cases, such as in the illustrative situation given in section III, chapter 5, it may be best to employ organic and attached engineer elements together under unified command.

SECTION III

ENGINEER SQUADRON*

■ 242. GENERAL.—The engineer squadron is the engineer component of the cavalry division. All transportation of this unit consists of motor vehicles and is adequate for simultaneous movement of all personnel and equipment. The squadron contains a headquarters and service troop and two lettered troops. The lettered troops are identical in organization with the lettered companies of the combat battalion. The headquarters and service troop is similar to but slightly smaller than the headquarters and service company of the combat battalion. For details of organization and duties see FM 5-5.

■ 243. CONSIDERATIONS AFFECTING EMPLOYMENT.—*a. Organization of cavalry division.*—The cavalry division contains two cavalry brigades, each of which consists of a headquarters troop and two cavalry regiments. The personnel and combat equipment of each cavalry brigade is transported almost entirely by horses, but each brigade includes a few vehicles for supply, reconnaissance, and liaison. The artillery component of the cavalry division includes two horse-drawn battalions of 75-mm howitzers for close support of the two cavalry brigades, and a truck-drawn 105-mm howitzer for support of the division as a whole. The cavalry division includes a reconnaissance battalion which contains three reconnaissance troops and a support troop. This unit is mechanized and includes 17 light tanks in the support troop.

*As long as any exist.

b. Combat teams.—The cavalry division is not usually organized into combat teams, but when the tactical situation makes it necessary the cavalry brigade may be reinforced by a horse-drawn howitzer battalion, engineers, and other elements as required.

c. Employment of cavalry division.—The cavalry division is best employed in areas where the terrain is unsuitable for operation of armored units. Such areas include large forests and mountains or hilly terrain. The cavalry division usually operates over wide frontages and frequently beyond supporting distance from large bodies of other troops. Elements of the division utilizing animals for transportation normally require little engineer assistance to facilitate their movement, but supporting elements other than the two horse-drawn artillery battalions are mostly motorized. Therefore they are dependent on engineer repair and maintenance of routes of movement to the same extent as other such motorized components. Forage and water supply are usually major problems.

■ 244. GENERAL EMPLOYMENT.—*a. Marches.*—During marches the engineer squadron, less elements attached to the reconnaissance squadron, is normally under control of the division engineer and marches as a unit. The attachment furnished by the engineer squadron to the reconnaissance squadron most frequently consists of a small reconnaissance party which has as its mission the gathering of engineer information. In some cases, it may be necessary to attach an engineer squad, platoon, or larger unit to assist the movement of the reconnaissance squadron and to initiate work necessary to facilitate the movement of the main body of the division. When attachments to the cavalry brigades are necessary to facilitate their movement during the march, the unit attached is most frequently a platoon. During the march the squadron does necessary engineer work to assist the advance of the division troops. Engineers may also be attached to flank guards during the march, usually to assist in the preparation of road blocks.

b. Operations during combat.—When the cavalry division is engaged in combat, the engineer squadron normally op-

erates under division engineer control. Engineer troops so employed maintain essential routes of communication and may be required to establish and defend obstacles for the protection of open flanks. Because of the wide frontages involved, it is often necessary during combat to attach elements of a squadron to other elements of the division. Even though the number of operating units available is small, the division engineer must at all times keep available an engineer reserve which can be promptly shifted to emergency engineer tasks.

c. River crossings.—The cavalry division frequently executes hasty river crossings in areas where enemy resistance is weak. When river conditions are suitable, the cavalry regiments may cross most of their elements by swimming and ferrying without engineer assistance. The engineer squadron may have attached a unit of six infantry support rafts; and this equipment can be used so as to provide 36 assault boats. Additional ramps may be carried with the equipage so that a solid deck can be placed on the rafts when animals are to be transported. This equipment can also be assembled into a bridge 288 feet long, which has a solid deck and sufficient load capacity to carry loaded 2½-ton trucks drawing trailers. The squadron may have 16 adjustable steel trestles, which may be employed with the ramps or with improvised decking for construction of trestle bridges. Twelve 6-ton pneumatic floats are carried, which can be utilized for construction of rafts for ferrying the tanks of the reconnaissance squadron.

d. Water supply.—Water-supply operations of a squadron must in some cases include the provision of sufficient water not only for the men but also for the animals. At times it may be necessary for the engineers to pump water from wells, cisterns, or streams with high banks into tanks, from which the animals can be watered, or into tank vehicles which transport the water to them. If necessary, elements of water-supply battalions may be attached to the squadron to assist in water-supply operations. For special requirements of engineer operations in desert or mountainous terrain see sections III and IV, chapter 6.

SECTION IV

ENGINEER MOTORIZED BATTALION*

■ 245. GENERAL.—The engineer motorized battalion is the engineer component of the motorized division. It contains a headquarters and a headquarters and service company, three lettered companies, and a reconnaissance company. Each lettered company has two platoons of three squads each. The platoons are considerably smaller than those of the combat battalion. The reconnaissance company differs from the lettered companies only in that it contains a reconnaissance platoon. The motorized battalion is provided with extensive armament, much of which is employed only on vehicular mounts manned by personnel normally assigned to other duties. It has extensive communication facilities and an ample supply of light transportation for reconnaissance and communication. The headquarters and service company includes an engineer train which transports considerable quantities of bridging equipment and extra explosives and antitank mines, giving the motorized battalion increased freedom from normal supply channels. For details of organization and duties of the motorized battalion see FM 5-5.

■ 246. CONSIDERATIONS AFFECTING EMPLOYMENT.—*a. Organization of motorized division.*—The organization of the motorized division is similar to that of the infantry division in most respects, but additional 2½-ton trucks are included in infantry regiments to transport those elements which, in the infantry division, normally move on foot. It contains a reconnaissance battalion consisting of three reconnaissance companies and a support company, rather than a single reconnaissance company as in the infantry division. The motorized division is normally reinforced by one or more tank destroyer battalions and is frequently reinforced by GHQ tank units. The only aviation organically assigned to the motorized division consists of light liaison-type airplanes for artillery observation.

*As long as any exist.

b. General employment of motorized division.—(1) The distinctive value of the motorized division lies in its ability to move rapidly over great distances in order to intervene in combat at decisive locations. It is frequently employed to follow up the rapid advance of armored units.

(2) For marches, the motorized division is organized into combat teams similar to those of the infantry division, except that the engineer component normally consists of a company rather than a platoon.

(3) The combat employment of the motorized division is generally similar to that of the infantry division. However, combat action by combat teams will be more frequent than in the case of infantry divisions.

(4) During the march, the motorized division may frequently operate over wider frontages than those of the infantry division, in order to take advantage of the best available roads. It may also enter combat on somewhat larger frontages. However, the areas occupied by motorized divisions in combat are generally comparable to those occupied by the infantry division.

■ **247. GENERAL EMPLOYMENT.**—*a. Marches.*—(1) As indicated above, the engineer component of the combat team normally consists of a lettered company. In a motorized division, the engineer component of the combat team needs to be stronger than in an infantry division for several reasons. Delay in a march is more serious in the case of the motorized division. Time and the greater areas traversed do not normally permit as thorough engineer reconnaissance or the execution of preparatory engineer work.

(2) During marches, the engineer company attached to a combat team is usually disposed so that one platoon and one vehicle of the reconnaissance section of company headquarters march with the advance guard of the combat team. The rest of the company marches near the head of the main body. Companies attached to combat teams frequently are reinforced by attachment of water-supply and bridging equipment from the headquarters and service company. The attachment of water-supply equipment permits more prompt establishment of a water-supply point to serve the units of the combat team. The attached bridging equipment permits

considerable saving of time in the construction of trestle bridges or short floating spans for passing the site of demolished bridges or other obstacles.

(3) For marches, the reconnaissance platoon is attached to the divisional reconnaissance battalion. This unit gathers engineer information, assists the advance of the reconnaissance battalion, and initiates essential engineer work to help the advance of the main body. The reconnaissance platoon normally operates as a unit, but in some cases reconnaissance personnel in $\frac{1}{4}$ -ton trucks accompany the reconnaissance companies, or, where need for engineer work is foreseen, squads may be attached to reconnaissance companies.

(4) During marches, the only reserves available to the division engineer consist of a reconnaissance company less one platoon, and the headquarters and service company. It is essential that he maintain contact with the companies attached to combat teams so that he can make recommendations for changes in dispositions of these units when required by the situation.

b. Operations during combat.—In combat, the general employment of the motorized battalion is similar to that of the combat battalion of the infantry division. However, the strength of the battalion available in working platoons is much less than that of the combat battalion and if the combat action is sustained it will frequently be necessary to attach corps engineers in order to provide sufficient engineer support. When the division commander assumes control of the artillery in order to coordinate the combat action of the division, the engineer attachments to the combat teams normally revert to the control of the division engineer. In the attack, each lettered company is usually placed in support of its corresponding infantry regiment unless that regiment is being held in reserve. When the reconnaissance battalion is withdrawn from the front or flanks into the division rear area, the reconnaissance platoon of the reconnaissance company customarily reverts to engineer control and is employed as a part of its company like other platoons of the battalion. The headquarters and service company normally operates in one echelon but may be divided into two, the engineer train remaining with the division service elements.

SECTION V

ENGINEER MOUNTAIN BATTALION *

■ 248. GENERAL.—The engineer mountain battalion is the engineer component of the mountain division. It contains a headquarters and a headquarters and service company, two pack companies, and a motorized company. Transportation of the pack companies is entirely by pack animals and is sufficient for moving all equipment simultaneously but not all personnel. The headquarters and service company and the motorized company contain only motor transportation and have sufficient transportation to move all personnel and equipment simultaneously. Armament of the battalion includes machine guns assigned to all companies except the headquarters and service company. For details of organization and duties see FM 5-5.

■ 249. ORGANIZATION AND EMPLOYMENT OF MOUNTAIN DIVISION.—

a. The basic combat elements of the mountain division are the three infantry mountain regiments. Each regiment has three battalions; and all transportation is by pack animals. The division artillery consists of four 75-mm pack battalions, which contain no motor vehicles. The quartermaster battalion consists of two truck companies and four pack companies.

b. The mountain division is so organized that its combat elements are not bound to motor roads but can move wherever pack trails are available. Service elements bring forward supplies by motor to truckheads where the supplies are turned over to combat units. The pack companies of the quartermaster battalion are also employed to deliver supplies to troops in areas inaccessible to motor vehicles. Often combat operations of the mountain division must be highly decentralized because of the conditions imposed by mountainous terrain. Artillery battalions may frequently be attached to infantry regiments and in some cases reinforced infantry battalions or companies may be assigned independent missions.

■ 250. OPERATIONS.—A general discussion of the special considerations affecting the operations of engineer units in moun-

*As long as any exist.

tainous terrain and under conditions of snow and extreme cold is given in chapter 6.

a. Pack companies.—The two pack companies of the engineer battalion normally are employed to assist directly in the operations of the combat elements of the division. They construct, improve, and maintain pack trails, and prepare obstacles and demolitions to deny such routes to the enemy. Operations of this nature usually require a high degree of decentralization so that in many cases the pack companies may operate by platoons or even squads; such elements are often attached to infantry and artillery units. Frequently it is necessary to attach portions of the supply section of company headquarters to platoons or other pack units assigned independent missions. In some cases engineer elements of pack companies may be attached to the cavalry troop of the division for reconnaissance or security missions to the front or flanks.

b. Motorized company.—The motorized company normally is employed under direct control of the division engineer, in preparing, maintaining, or obstructing routes of movement suitable for use by motor vehicles. It maintains routes necessary for the movement of supplies from the rear to truck-heads within reach of pack trains of the combat elements. Air-compressors, bulldozers, and other mechanized equipment for the passage of obstacles are found only in the motorized company.

c. Headquarters and service company.—The headquarters and service company of the mountain battalion normally operates in one echelon. It does not have mechanical equipment for reinforcing subordinate units of the battalion. The only river-crossing equipment assigned the mountain battalion consists of 6-ton pneumatic floats, which may be used to construct ferries or short bridges with decks improvised from materials obtained locally.

SECTION VI

ARMORED ENGINEER BATTALION

■ 251. **GENERAL.**—The armored engineer battalion is the engineer component of the armored division. It contains a head-

quarters and headquarters company, and four lettered companies. Each lettered company has three platoons of three squads each. The headquarters company contains a reconnaissance platoon which has three small reconnaissance sections, three operating squads, and a platoon headquarters. The armored battalion is provided with radio communication down to and including the platoon headquarters. There is sufficient armament, if employed properly, for the defense of engineer working groups against small hostile mechanized or infantry parties. For details of organization and duties see FM 5-5; for details of employment see FM 17-45.

■ 252. CONSIDERATIONS AFFECTING EMPLOYMENT.—*a. Organization of armored division.*—The armored division contains two armored regiments, each of which has two medium tank battalions and one light tank battalion. The artillery component consists of three battalions of eighteen 105-mm howitzers each. For reconnaissance, the armored division has a battalion consisting of three reconnaissance companies and a light tank company. Normally the armored division is reinforced by attached or supporting tank-destroyer units, and observation and combat aviation.

b. Combat commands.—The armored division has no fixed combat team or brigade organization, but it contains two combat commands used by the division commander to direct and control the operations of various tactical groupings made up within the division. This unit is tactical only. The combat command may contain tanks, infantry, engineers, and artillery; tank units and engineers; tank units, artillery, and tank destroyer and engineers; or other combinations of units. In most cases a combat command is built around an armored regiment. In all cases the exact grouping and strength of each combat command group is determined by the particular tactical mission to be accomplished. Certain combat elements other than those assigned to combat commands are normally held under direct control of the division commander. Service elements form the rear echelon of the division and operate under the commander of the trains.

c. Territorial assignment.—An armored division differs somewhat from other divisions in that it is seldom assigned territorial responsibility for a portion of the combat area.

In the attack it may be assigned sectors of advance but these normally coincide with those of other divisions which have territorial responsibility for the area captured.

■ 253. GENERAL EMPLOYMENT. — *a. Dispositions.* — Engineers are normally included in each combat command of the division. The usual attachment to a combat command containing an armored regiment is a company. Standing operating procedures usually cover the engineer components of combat commands, but the division engineer makes recommendations to the division commander regarding the strength and composition of engineer attachments in each case. The reconnaissance platoon of headquarters company is normally attached to the reconnaissance battalion of the division. Usually the engineer battalion, less those elements attached to combat commands and to the reconnaissance battalion, operates under the direct control of the division engineer. He directs its activities on engineer work for the benefit of the division as a whole, and when necessary uses it to reinforce engineers attached to other elements of the division. Because of fatigue or other conditions, it may be necessary in many cases to replace the engineer component of a combat command with fresh engineer troops from among those held under control of the division engineer.

b. Companies with combat commands. — The position of the engineer element of a combat command during marches should be well forward in the column. The reconnaissance personnel of engineer companies attached to combat commands usually accompany the reconnaissance elements of the respective combat commands. One platoon of the company should be with the advance guard and the rest of the company, less attachments, well forward in the main body. This is particularly important when the use of heavy engineer equipment is contemplated, since this equipment is difficult and slow to move past a halted column when needed to replace a bridge or for similar purposes. Each lettered company of the armored engineer battalion is organically assigned a water-supply set which is used to set up and operate a water-supply point for the use of a combat command to which it may be attached. Bridging equipment from a tread-way bridge company may be broken down into units of 30

feet or multiples thereof for attachment to combat groups or march columns.

c. Reconnaissance platoon.—This platoon is the normal attachment to the division reconnaissance battalion. Normally one of the engineer reconnaissance sections of the platoon accompanies each company of the division reconnaissance battalion for the purpose of gathering engineer reconnaissance information needed by the division engineer. The remainder of the platoon assists the movement of the reconnaissance battalion by engineering work. One or more operating squads may be attached to reconnaissance companies when it is expected that they will be required for such work as overcoming obstacles or executing demolitions on the flanks. The reconnaissance platoon is reinforced when necessary for accomplishment of its mission.

d. Treadway bridge company.—(1) This company is equipped with bridge equipage of sufficient capacity to carry all organic loads of the armored division. It is usually employed in hasty or weakly defended crossings, since the armored division is not well adapted to the forcing of a strongly defended river line. Ordinarily the treadway bridge company is attached to the armored engineer battalion.

(2) Equipment carried by the company provides short-span fixed bridges, 6-ton pneumatic floats, rafts, or treadway bridge. However, bridge expedients, detours, or fords are used whenever possible to avoid the time required to construct bridges.

(3) When an attacking armored division reaches an undefended river line, leading elements cross at once, assisted by attached engineers.

(4) If the river line is weakly held, crossings in an initial wave are made in reconnaissance boats, under cover of supporting fires. Supporting weapons are crossed in a second wave as soon as practicable. Later, heavy rafts are put into operation and the treadway bridge is constructed. All crossing means are utilized continuously until the bridgehead is complete.

(5) If a forced crossing must be accomplished by an armored division alone, it is done according to the principles given in chapter 5.

e. Rear echelon.—The transportation platoon of head-

quarters company normally moves with the division trains and constitutes the rear echelon of the battalion. In some cases certain portions of the lettered companies may also be included in the rear echelon.

f. Desert warfare.—Armored units are particularly suitable for employment in desert warfare. Special considerations applicable to engineer units operating in desert areas are discussed in chapter 6.

SECTION VII

AIRBORNE ENGINEER BATTALION*

■ 254. *GENERAL.*—*a.* The airborne engineer battalion is the engineer element of an airborne division and operates to increase the combat effectiveness of the division by performing engineer tasks within the limitation of its personnel and equipment. It employs its personnel and equipment to assist the division, first to gain objectives and then to hold them. Except in an emergency, the engineer elements of the division are not employed as infantry.

b. The battalion consists of a headquarters and service company, a parachute company, two glider companies, and a medical detachment. Transportation is sufficient for supply, administrative, and training purposes while the battalion is in bivouac or emplaning areas, and for limited engineer missions. There is not sufficient transportation to move all equipment and personnel simultaneously. Troops are armed with carbines, submachine guns, light machine guns and antitank guns. Battalion equipment is light in weight for transportation by air. It includes bantam tractors and angle-dozers, $\frac{1}{4}$ -ton trucks and trailers, pneumatic boats, portable gasoline saws, and demolition equipment. The battalion carries no bridging equipment. Air transportation is furnished by the air forces. Details of the organization and duties of airborne engineer battalion are shown in FM 5-5.

■ 255. *CONSIDERATIONS AFFECTING EMPLOYMENT.*—*a. Organization of airborne division.*—The airborne division consists of airborne artillery, one parachute infantry regiment, two glider infantry regiments, an antiaircraft battalion, an en-

*As long as any exist.

gineer battalion, one company each of ordnance, medical, signal, and quartermaster troops, and a military police platoon.

b. Employment of parachute company.—The engineer parachute company is normally attached to the parachute regiment of the airborne division for specific operations. Glider companies normally accompany the glider infantry regiments of the division.

In preparing the parachute company for emplaning for transportation to the objective, the company commander plans the employment of his company; studies maps and aerial photographs of the area of operation and the dropping zone; checks individual clothing and equipment, rations, weapons and ammunition, and the engineer supplies and equipment needed to accomplish the engineer tasks involved in the mission. The parachute company is prepared to demolish enemy communications, airdrome installations, factories, docks, utilities, supplies, and equipment. It can assist in the assault and capture of fortifications and trenches; construct and remove road blocks, mine fields, and obstacles; seize and remove charges from bridges and important installations prepared for demolition by the enemy; capture and convert for use enemy mechanized vehicles; and execute minor and hasty repairs to landing fields for glider-borne elements of the division.

c. Employment of glider companies.—Glider companies are capable of executing more extensive engineer work than the parachute company. One of the first duties on the ground is to repair landing fields to make them reasonably safe for landing airplanes. For this purpose each company has a special bantam weight tractor and angledozer. Glider companies are prepared to construct and defend obstacles; execute demolitions; improvise, strengthen and repair bridges; make minor repairs to communications and local water supplies; and seize, repair and convert to use enemy vehicles and equipment.

d. As division engineer, the battalion commander has the additional duty of engineer reconnaissance of the objective by air, and the supply of adequate maps and air photographs to the division and to the air forces in advance of the operation. Ground reconnaissance begins immediately on landing.

CHAPTER 12

OPERATIONS OF OTHER UNITS WITH GROUND FORCES

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SECTION I

GENERAL

■ 256. **NONDIVISIONAL UNITS.**—In any balanced force of considerable size, the combat engineer units of the divisions comprise only a fraction of the total engineer strength. Previous chapters have emphasized the operations of division engineer units. However, the bulk of the engineer work in a theater of operations is executed by other engineer troops assigned to higher echelons of the Army Ground Forces, the Army Air Forces, and the Army Service Forces. This chapter and chapters 13 and 14 discuss the work of nondivisional engineer units.

■ 257. **CONSTRUCTION OPERATIONS.**—Construction work done under combat conditions by division engineer units must necessarily be of a hasty and temporary nature, fitting the minimum requirements of the immediate tactical situation. When the situation permits, such construction is usually supplemented or replaced by work of a more adequate and permanent nature executed by general engineer units under control of the unit engineer of a higher echelon. In addition, engineer units in rear areas execute major construction projects to provide necessary facilities and routes of communication for the operation of large military forces. The engineering requirements and standard plans governing the conduct of such construction projects are described in FM 5-10, TM 5-255, and other Field and Technical Manuals.

■ 258. **OTHER OPERATIONS.**—Engineers are provided for engineer supply, mapping, camouflage advice and inspection, operation of utilities, and other functions assigned to the

engineer service. Although in some cases general engineering units may engage in these operations, they are conducted principally by special engineer units organized and equipped for the execution of special work. New types of special engineer units are organized as the need arises. The technique employed in the conduct of such special work is generally described in Technical Manuals.

■ 259. ASSIGNMENT OF ENGINEER UNITS.—General and special engineer units are assigned to corps, armies, the communications zone, the air forces, the Army Service Forces, and the theater reserve in such manner as to provide each echelon with the necessary means for the conduct of its operations. In general the assignment of units to each force provides it with only the minimum means necessary to meet its normal requirements. Exceptionally heavy or unusual requirements are met by attachment of units under control of the higher headquarters.

■ 260. ORGANIZATION AND DUTIES OF UNITS.—The organization and duties of engineer units are described in FM 5-5. The scope of operations of a special engineer unit is generally much more limited by its organization than that of a general engineer unit.

SECTION II

ENGINEER COMBAT BATTALION (CORPS)

■ 261. GENERAL.—a. Engineer combat battalions normally form part of a corps. In some cases combat battalions may be assigned to field armies or held in theater reserve. In all cases the combat battalions should be employed on those types of engineer operations for which their organization and equipment make them especially suitable. They should not be employed on tasks which can be performed efficiently by general service regiments or special engineer units. They may be grouped under a single commander reporting to the corps engineer, and supported by a headquarters and service company.

b. Corps engineer combat battalions are employed in engineer work of destruction and on construction and mainte-

nance work mainly of a pioneer nature. Their principal missions are as follows:

- (1) Maintenance and repair of communications.
- (2) Reinforcing division engineers.
- (3) Preparation and defense of obstacles.
- (4) Furnishing direct assistance to combat units not assigned to divisions.

■ 262. MAINTENANCE AND REPAIR OF COMMUNICATION.—Corps and army engineers are responsible for maintenance of communication in the service areas of their respective units. Normally, the corps engineer has only combat battalions for employment on such work, but the army engineer may frequently have available both combat battalions and general service regiments. In general, corps combat battalions should be employed for the work in areas where contact with enemy ground forces is likely, where the work consists of many small and widely-dispersed tasks, and where enemy artillery and aerial bombardment results in frequent and serious interruption to routes of communication. General service regiments should be employed where the work to be done consists primarily of large tasks requiring a considerable concentration of men and machinery. Resurfacing roads and construction of major bridges are examples of such tasks. When the corps has no general service units attached, work of this nature in the corps service area should be taken over by the army.

a. Dispositions for work on communication in corps service area.—(1) In organizing for maintenance of communication in the corps service area the corps engineer normally assigns portions of the area to each of his combat battalions, making each battalion responsible for the maintenance of all communication within that area. In some cases the entire corps service area may be assigned to one of the battalions and the other battalions may be employed on special work such as the preparation and defense of a flank barrier zone. The work may also be assigned to both units by tasks, but for such large units, the splitting of communication work into tasks is generally undesirable. In assigning areas for maintenance of communication, the corps service area may be divided laterally or longitudinally. If battalions are placed

abreast, control is facilitated, since movement is generally perpendicular to the front and does not have to cross the general traffic of other units. Such dispositions also facilitate adjustments following an advance or a retrograde movement, and place each battalion in a position where it can take over a portion of the work in the service area of the divisions in front. If the corps battalions are placed in column, some disadvantages are introduced, but this arrangement enables one battalion to be leap-frogged over the other battalion, thereby retaining the advantage of having the unit in the same area for the maximum length of time.

(2) In deciding on the areas to be assigned, the following should be especially considered in order to equalize the work assigned and provided for its efficient execution:

(a) Road net.

(b) Amount of work required of engineers in each area.

(c) Amount of interference with engineer work to be expected from enemy activities and from congestion of roads or other interference from own troops.

(d) Suitability of shape of area selected from point of view of ease of communication and control. Thus, an area which is roughly square makes control simpler than an area which is long and narrow.

b. Execution of engineer work in division rear areas.—Combat battalions of the corps are at times assigned work on communication in the rear area of a front-line division without being placed under command of the division. In such case the work is executed under the direction of the battalion commander and the corps engineer. However, in order that the work may meet the needs of the division and not conflict unnecessarily with the work requirements of the corps service area it must be carefully planned and coordinated. The exact nature and extent of the work to be done must be clearly specified so as to be understood by the division engineer, the corps engineer, and the commander of the unit executing it. The commander of the unit establishes liaison with the division engineer and executes all requests by the division engineer within the limits of the work assigned and the capabilities of the unit. The assignment most frequently is maintenance of all communication in the division area in rear of a specified boundary. In other cases, however, it

may consist only of maintaining a specified main supply road as far forward as a stated point, or in the building of an important bridge.

■ 263. REINFORCING DIVISION ENGINEER UNITS.—The combat battalions of the corps are the only sources from which divisions can be reinforced with combat engineers. Such reinforcement is necessary in many combat operations, such as a pursuit, a river crossing, or the attack of an organized position where a high proportion of combat engineers is required well forward with the leading infantry elements. In such cases the relief of division engineer units from work in the division rear area usually does not suffice to meet the needs of the division and attachment of combat engineers is necessary. Combat engineers thus attached are trained for and may be used on any of the operations in which division engineer units are usually employed.

a. Although the attachment furnished a division generally consists of one or more entire battalions, it may consist of a portion only. In the latter case, an appropriate headquarters should be furnished to assist in supervising the work. When a portion of a combat battalion is attached to a division, the battalion commander is no longer responsible for supply of the attached elements. However, he should continue to give them such support as is possible without neglecting other work assigned the battalion by higher authority. Such support consists of supplying engineer materials, transportation, or equipment and specialists assigned to the headquarters and service company.

b. When a corps combat battalion is attached to a division it is normally attached to the division engineer battalion even though the commander of the corps combat battalion is senior to the division engineer. In any case the division engineer continues in that capacity despite the presence of a senior engineer officer.

■ 264. PREPARATION AND DEFENSE OF OBSTACLES.—Important duties of the corps combat battalion are to create obstacles for the defense of the flanks and rear, to defend the rear area against penetration of enemy mechanized elements, to assist in the defense against airborne troops; and, in a retrograde

movement, to delay the advance of the enemy by preparing obstacles. (See FM 5-30.) The corps combat battalion may be charged with the responsibility for preparing and defending obstacles or for their preparation only. Where responsibility is for preparation only, the unit preparing the obstacles is normally attached to the unit which is to defend them. The engineer battalion is mobile and strong in machine guns and antitank weapons. Obstacles constructed in depth within the corps and army areas usually are prepared only, and not executed initially. Paragraph 232c discusses methods of controlling the execution of prepared demolitions. For a discussion of defense of road blocks see chapter 4.

■ 265. FURNISHING DIRECT ENGINEER ASSISTANCE TO NONDIVISIONAL UNITS.—Corps combat battalions furnish direct engineer assistance required by those combat elements of other arms not operating under division control. The engineer element is normally attached to the unit which it assists, though in some cases it may be placed in support. The artillery operating under control of corps or army may frequently require engineer assistance for displacing its heavier weapons and for executing some phases of the fortification of gun positions. The corps cavalry regiment (mechanized) frequently requires attachment of combat engineers to assist its operations by execution of engineer reconnaissance, by removal of road blocks or other engineer work in the advance, and by execution of demolitions and preparation of road blocks in counterreconnaissance and security missions. Tank destroyers and tank units operating under corps or army control may require attachments of treadway bridge companies and of combat engineers to assist their movement; to assist in the protection of their bivouacs, rallying points, and other advanced positions; and to establish and defend obstacles designed to direct the movement of enemy tanks into localities in which they can be more easily destroyed.

■ 266. OTHER OPERATIONS.—In addition to the operations discussed in preceding paragraphs there are several other less common or less extensive types of operation on which elements of the corps combat battalion may be employed. They include—

a. Water supply.—The supply operations of a corps combat battalion are normally limited to those necessary for the supply of its own elements. An exception to this general rule is water supply. The headquarters and service company of the battalion is equipped with four water-supply sets which it employs for establishing water-supply points for the use of all troops in the area in which the battalion is operating. For a discussion of the location and operation of water-supply points see section IV chapter 10.

b. Reconnaissance.—~~Reconnaissance~~ Reconnaissance is a continuing function of all engineer combat units. The initial engineer reconnaissance of captured areas is executed by division engineer units, but a more complete reconnaissance is made by the corps engineer combat battalions which follow them. Commanders of combat battalions also conduct continuing engineer reconnaissance of the areas assigned them in order to plan the work of their units efficiently and to keep higher commanders informed of the status of communications in the area, the location of ponton bridge sites, and of any other considerations which might influence the employment of engineers.

c. Lay-out and construction of fortifications.—Corps combat battalions may be employed to lay out and mark the position of fortifications to be constructed on rearward positions. Less frequently they may be employed to construct fortifications. A discussion of this subject is given in chapter 7.

d. Construction of landing fields.—When necessity requires and no other engineer troops are available, elements of a corps combat battalion may be employed to construct or repair advance landing fields.

e. River-crossing operations.—The normal employment of a corps combat battalion in a river-crossing operation is to reinforce a division engineer unit and engage in any related activity on which such a unit may be employed. In some cases, however, the corps combat battalion may be employed to construct bridges or ferries or to reinforce ponton units in the execution of such tasks when they are performed under direct control of corps or army.

f. Combat.—Corps combat battalions may be employed in emergencies for combat as infantry. Enemy ground forces

may penetrate forward lines or flank security forces and appear in rear areas, and airborne troops may be landed in corps and army service areas. In such cases the corps combat battalions, being well distributed over the rear areas, mobile, and well armed, may be employed to hold such elements in check pending the arrival of larger forces, or may counterattack and destroy them. Engineer units once committed to infantry operations are difficult to withdraw for execution of engineer tasks.

SECTION III

ENGINEER GENERAL SERVICE REGIMENT

■ 267. GENERAL.—*a.* The engineer general service regiment performs general work, particularly that requiring a high percentage of skilled labor, throughout the theater of operations. A general service regiment is capable of executing more extensive and more permanent work than the combat units, because of its large headquarters organization, greater number of specialists, and special mechanical equipment. A regiment consists of a headquarters and service company, a medical detachment, and two battalions of three companies each. Arms include machine guns, both .30 and .50 caliber. Its equipment includes angledozers, $\frac{1}{2}$ -yard shovels, an earth auger, graders, air compressors, a motorized shop, welding equipment, and water-supply sets. It has no stream-crossing equipment. It does not have transportation sufficient for moving personnel and equipment simultaneously. It may be reinforced by special engineer units as needed.

b. The general service regiment may be employed on either an area or a task assignment within the army service area.

(1) Frequently, the entire army service area is divided up and each portion assigned to a general service regiment, which is made responsible for all engineer work in the area, with the exception of tasks assigned to special engineer units or otherwise specifically excepted. Units given area assignments are frequently reinforced by the attachment of dump truck companies, elements of equipment companies, and such other engineer units as may be required.

(2) Typical task assignments include reconstruction or repair of a railroad or of principal highway, construction of

a major bridge, or construction of deliberate field fortifications including concrete structures.

c. Normally the commander of a general service regiment subdivides work among subordinate units and distributes them widely, keeping each unit near the site of its work. When the regiment is given an area assignment, the area is frequently subdivided and assigned to the battalions. The headquarters of the general service regiment is employed to make engineering plans, inspect the work of lower units, and supply necessary materials and, in some cases, technical specialists.

d. Construction executed by general service units in the army service area is normally more dispersed and more temporary in nature than that of similar units in the communications zone. Large depots, hospitals, cantonments, and utilities are not constructed close to the front line. Road maintenance and improvement is normally executed by the use of gravel, macadam, or bituminous materials, with construction methods of a hasty nature. Bridges are of timber or may be of standard ponton or prefabricated steel types. General service regiments are frequently employed to improve roads initially repaired and maintained by combat units and to construct bridges of greater strength, permanence, and traffic capacity to replace those constructed by combat engineers to meet the immediate needs of the tactical situation. Construction and maintenance of advanced airdromes in the army service area is normally a function of aviation engineer units, but when such units are not available the work may be executed by general engineer units.

SECTION IV

SPECIAL ENGINEER UNITS

■ 268. ENGINEER TOPOGRAPHIC BATTALION (ARMY).—a. This special mapping unit is equipped to prepare and reproduce photomaps, make overlays, sketches, and maps of limited areas, and revise and reproduce existing maps. Its primary mission is to provide, in the shortest practical time, map information adequate for the tactical and strategical requirements of the army. All mapping and reproduction equip-

ment of the army topographic battalion is mobile. It normally operates in one locality.

b. The battalion has the additional mission of extending survey control forward so that it can be utilized by the corps engineer topographic companies and the field artillery. This is necessary if the artillery is to fire accurately under adverse conditions and is especially important where available control is limited. The survey companies establish and extend horizontal and vertical control for artillery requirements and supply the necessary ground control for mapping.

■ 269. ENGINEER TOPOGRAPHIC COMPANY (CORPS).—This unit executes surveys, prepares simple maps and map substitutes, and reproduces maps, map substitutes, and sketches for the corps. It is fully mobile and normally bivouacs near corps headquarters. The company consists of a survey platoon, a photomapping platoon, and a reproduction platoon. The survey platoon is employed to extend survey control from points established by civilian agencies or by the army topographic units to points which can be utilized by survey elements of the artillery. The survey platoon also locates necessary points for control of aerial mosaics. The photomapping platoon executes necessary photogrammetric and drafting work for preparation of maps, mosaics, overlays, and overprints for reproduction by the reproduction platoon. Preparation of maps by this platoon is generally limited to those prepared from aerial photographs by the use of stereocomparagraphs. The reproduction platoon reproduces by lithography, black-and-white process printing, or gelatin duplication, using copy produced by the photomapping platoon or prepared in corps or division headquarters.

■ 270. ENGINEER LIGHT PONTON COMPANY.—The engineer light ponton company maintains and transports stream-crossing equipment including the 10-ton pneumatic ponton bridge M3, the 10-ton ponton bridge, infantry support rafts, footbridge, and assault boats. It has sufficient organic transportation for simultaneous movement of all personnel and equipment. Ponton companies are attached to the corps and divisions as needed.

a. The company is normally attached to a division for river-crossing operations and, in this case, its operations are

directed by the division engineer. Since secrecy is always desired in river-crossing operations and bridging equipment is difficult to conceal, the company is held well to the rear in the army or corps service area until just before it is to be used. The ponton company normally constructs the bridge of the 10-ton equipage, with the assistance of such general engineer troops as the division engineer makes available. The lighter equipment of the company is turned over to the divisional engineers for use in the initial stages of the river crossing.

b. The company is also employed to instruct other engineer units in the use of the equipment, to guard and maintain the completed ponton bridge, to regulate traffic on it, and to dismantle the bridge when it has been replaced by a more permanent structure or is no longer required.

■ 271. ENGINEER HEAVY PONTON BATTALION.—The heavy ponton battalion maintains and transports stream-crossing equipment including the 25-ton ponton equipage, infantry support rafts, footbridge, assault boats, and storm boats. Its equipment is normally sufficient to meet all needs of an infantry division crossing a river less than 600 feet wide. The battalion is normally attached to corps or divisions for a river-crossing operation and is employed in a similar manner to the light ponton company.

■ 272. CAMOUFLAGE UNITS.—Camouflage units increase the effectiveness of camouflage measures by inspection, assistance in training, planning, manufacture, and supply. Erection of camouflage materials is *not* normally the duty of camouflage troops, as the numbers available are far too small for any major effort of this type.

a. The *camouflage battalion* is assigned to a field army and assists in the execution of camouflage operations within the army area. Companies and platoons of the battalion are usually distributed throughout the army area, a portion of the area being the working territory of each unit. Preferably the camouflage units should arrive in their respective areas before the units who are to occupy the areas and, at the latest, they must arrive at the same time so that camouflage may be planned from the start and not merely added later to installations already built. It is desirable to have a camou-

flage unit operate continuously in a given area in order to give continuity to the camouflage policy even though the tactical units may change. Major camouflage projects for installations common to all arms are normally planned by the camouflage unit but are executed by general engineer units. Minor projects common to all arms are sometimes carried out by camouflage troops. In a rapidly moving situation those installations which remain in the same locality for the longest periods, such as important supply points, receive the most attention from the battalion.

b. The camouflage company, separate, is organized primarily for duty with an independent corps. It performs the same functions for an independent corps as the army camouflage battalion does for an army.

■ 273. ENGINEER HEADQUARTERS UNITS.—An engineer headquarters is organized to provide the officer and enlisted overhead personnel to coordinate and direct the engineer operations of larger commands.

■ 274. ENGINEER WATER SUPPLY BATTALION.—Operations of this unit in the army area are discussed in section IV, chapter 10. In the forward portion of a communications zone, this unit conducts operations generally similar to those of like units in the army area. In rearward areas, water is normally provided by more permanent facilities and water supply battalions are not required.

■ 275. ENGINEER MAINTENANCE COMPANY.—This unit executes third echelon maintenance of all equipment for which the engineer troops have maintenance responsibility. Usually two or more are required by each field army. Its repair shops are mobile. The maintenance platoons make repairs on equipment that can be moved to their base or bases of operations. The contact platoon makes emergency repairs to equipment that cannot be easily moved. The company is characterized by its ability to maintain close contact with units served, while providing third echelon maintenance in forward areas.

■ 276. RECOVERY.—Engineer recovery operations must be coordinated with the recovery operations of quartermaster

salvage and recovery units and with the recovery operations of ordnance evacuation companies. The facilities of the quartermaster recovery units and of the ordnance evacuation companies are available to engineer units as required.

■ 277. CONCEALMENT.—Motorized shops and equipment being worked on in the bivouac shop area must be located so as to utilize a maximum of natural concealment. Motorized shops should be disposed as far from each other and from the power unit as available cable permits. Incoming equipment should be scattered and concealed in an equipment park and held there until such time as it can be moved into the bivouac shop area. While in the shop area it should be kept at least 50 feet from the nearest shop. Outgoing equipment should be dispatched without delay or when necessary disposed of in a similar manner. During occupation of the bivouac area, camouflage discipline must be strictly enforced.

■ 278. ENGINEER DEPOT COMPANY.—One or more engineer depot companies are normally assigned each field army to assist in receiving, storing, and issuing engineer supplies. For a discussion of the operations of depot companies in the army service area see section III, chapter 10.

■ 279. ENGINEER DUMP TRUCK COMPANY.—Dump truck companies supply transportation for movement of bulk materials in connection with engineer operations. In the field army they are normally attached to general engineer units. They are used on road and railroad construction involving earth cuts and fills, bridges, and the placing of road metal and track ballast; on airdrome construction involving clearing, grading, and construction of runways; and on field fortifications involving large quantities of engineer materials. For operations, the dump truck company is frequently broken up into platoons or sections and attached to general engineer troops distributed over a wide area. In such situations, company headquarters is attached to the unit to which the bulk of the company transportation is attached.

■ 280. ENGINEER LIGHT EQUIPMENT COMPANY.—a. Engineer light equipment companies are organized, trained, and equipped to form a flexible pool of light mobile equipment and

skilled operators for attachment to division, corps, and army engineer troops in forward areas. The mobile equipment is that necessary for construction and demolition, supplementing the organic equipment of a balanced corps of three divisions on average terrain. The personnel of the company is sufficient to operate, maintain, and distribute the equipment, and to service the company. The operation and construction planning are by corps and army engineer headquarters and the tactical unit to which the company is attached, in accordance with the engineering needs of the tactical plan.

b. The equipment includes air compressors, tractor-mounted angledozers, road graders, cranes, motorized earth augers, $\frac{1}{2}$ cubic yard shovels, trailers for its shovels and tractors, and necessary shop and welding equipment for maintenance of its own equipment.

CHAPTER 13

OPERATIONS OF ENGINEER TROOPS WITH AIR FORCES

■ **281. GENERAL.**—*a.* In a theater of operations, the air forces normally operate directly under the theater commander. Elements are attached to field armies or other ground force units when required for special purposes.

b. Engineer missions pertaining to the air forces consist primarily of constructing, maintaining, camouflaging, and defending field airdromes. Construction tasks range from runways hastily cleared on advanced landing fields to permanent air bases. Such missions are normally performed by engineer units assigned to the air force. However, any other general engineer units may be called upon to carry out such missions under the direction of the air force engineer or the unit engineer of a subordinate air force unit. General service regiments, equipment companies, maintenance companies, depot companies, and army camouflage battalions are likely to be employed in the construction of airdromes in the rear area. Combat battalions may work on advanced landing fields.

■ **282. ENGINEER AVIATION BATTALION.**—Engineer aviation battalions are the basic engineer units organized to do general engineer work required by the air forces. They are organized, trained, and equipped to construct airdromes, to maintain and repair them, and to assist in their defense.

a. Organization.—The aviation battalion consists of a headquarters and service company and three lettered companies. Each lettered company has sufficient equipment to construct, repair, and maintain landing fields. Headquarters and service company has facilities for maintaining and repairing equipment and additional heavy equipment to assist the lettered companies. Sufficient personnel is provided for 24-hour operation of all heavy equipment. The battalion is not completely motorized—all personnel can be carried in one move provided all vehicles are used, but the prime movers must make several trips to bring equipment forward.

b. Construction operations.—For construction of an airdrome the entire engineer aviation battalion is normally employed as a unit. The work to be done is subdivided. A suitable task, such as construction of runways, access roads, or splinterproof emplacements, is assigned to each of the various companies, and work progresses concurrently. Headquarters and service company supplies necessary materials and furnishes additional construction equipment to the companies whose operations require its use. However, in many instances an individual company will be required to build an entire airdrome without additional help.

c. Maintenance operations.—Ordinarily, for maintenance and repair work, the battalion is not employed at a single site; it may be assigned to do the necessary engineer work on airdromes within a certain geographical area or on those of a particular air force unit or air base. Normally, some elements of the battalion are stationed at each airdrome to meet routine needs for maintenance and improvement work and to make initial repairs if the airdrome is damaged by enemy action, while a reserve is retained at a convenient location to meet maintenance or improvement needs beyond the capability of the unit at any assigned field. When a field is severely damaged by enemy bombardment, this reserve moves there rapidly by motor and restores it to operating condition as rapidly as possible. In extreme cases all elements of the battalion may be concentrated for rapid repair of a damaged field or fields.

d. Defense of airdromes.—Engineer units used for maintenance and repair of airdromes are normally also employed for their defense. Weapons organically assigned include caliber .30 and caliber .50 machine guns which can be used for defense against attack by airborne troops and low-flying airplanes. Engineers stationed at the airdrome for routine repair and maintenance work normally are assigned defensive stations from which they can fire on enemy aircraft and airborne troops attempting to land on or near the landing field. The reserve of the engineer battalion is frequently employed to assist in counterattack against enemy airborne forces. For a more complete discussion of the defense of airdromes see TM 5-255.

e. Importance of equipment.—Construction equipment is essential to rapid execution of construction tasks. Since this equipment is heavy, it will often be difficult to move forward, but if new airdromes are to be built quickly, this difficulty must be overcome by proper staff planning. Without construction equipment, the aviation engineer battalion is but little better for construction purposes than an infantry force of the same size.

■ 283. ENGINEER AVIATION COMPANY.—The separate company of aviation engineers is organized exactly like a company of the battalion. It is used for small construction programs or for maintenance at airdromes remote from localities where similar work is required.

■ 284. AIRBORNE ENGINEER AVIATION BATTALION.—*a. General.*—Airborne engineer aviation battalions are organized, trained, and equipped to go by air to captured airdromes to prepare them for the landing of airborne divisions. Speed of movement and speed of operation are characteristics of these battalions. The battalion consists of a headquarters and service company, a medical detachment, and three construction companies. The construction equipment is of the same type as that carried by the engineer aviation battalion, except that it is of light weight and bantam proportions for accommodation in and transportation by glider and airplane.

(1) In an airborne operation advanced landing fields, often in the enemy's rear areas, are essential to the landing of airborne divisions, to the supply of airborne units, and to the air and ground support of airborne units. The leading echelons of an airborne command, the paratroops, and glider troops seize and hold enemy airdromes for the use of friendly aircraft. The combat engineers of the airborne command secure, prepare, and mark lanes, at least 50 feet by 600 feet, for reasonably safe glider landings.

(2) The mission of the airborne engineer aviation battalion is to place the airdromes in operation for advanced air-ground support fighters, light bombers, and observation airplanes, and for the landing of the division. The first increment of airborne aviation engineers arrives by glider with their lightweight equipment. They reconstruct and

mark more extensive landing strips, at least 150 feet by 3,000 feet, for the reasonably safe landing of transport and cargo airplanes. The second increment of airborne aviation engineers arrives by glider or airplane with heavier equipment, to enable companies of the battalion to do heavier and more finished repair work. The second echelon also supplies materials needed by the construction companies, including fuel, asphalt, explosives, ammunition, and rations.

(3) The quantity and bantam proportions of the equipment brought in by air limit the extent of the work that can be accomplished. Airborne aviation engineers utilize their equipment specifically to fill bomb craters in runways, to neutralize contaminated areas, to detect and remove mine fields and booby traps, and to clear obstacles and wrecked airplanes from landing strips. When heavier equipment cannot get forward, entire runways may be constructed with this equipment, provided the site is favorable and no excessive amount of earthmoving is involved.

(4) Succeeding increments of aviation engineers complete the work and extend it to the rehabilitation of access roads, utilities, field lighting, and gasoline supply.

b. Equipment.—Engineer tools and equipment of the airborne engineer aviation battalion includes the following small, lightweight special equipment: air compressors with saws, tampers, and drills; light crawler tractors with bulldozers; asphalt repair equipment; portable electric light sets for night lighting of areas under repair; leaning-wheel graders; gasoline motor driven hammers and chain saws; mine detectors; road material mixers; sump pumps; rollers, scrapers, rooters, and rubber-tired tractors; welding and cutting equipment; water-supply equipment; and normal engineer tool sets. Communication equipment is limited to radio from company to battalion headquarters and from battalion to task force headquarters, signal panels for airplanes, and bicycle messengers.

c. Armament.—Airborne engineer aviation battalions are trained to provide for their own security and to fight as infantry in an emergency. Arms include carbines, rifles, submachine guns, and .50 caliber antiaircraft guns. Nevertheless, the unit is primarily a service unit and should not

be used as a combat force. A unit once committed to combat is difficult to withdraw for repair operations.

d. Use in amphibious operations.—For landing operations where port facilities are not available, the light equipment of an airborne engineer aviation battalion is more suitable than the heavier equipment of the standard battalion. For this reason these battalions may be used for the rehabilitation and construction of airdromes in such operations.

■ 285. ENGINEER AVIATION CAMOUFLAGE BATTALION.—This unit is similar to the engineer camouflage battalion of the army. It furnishes technical assistance, supervision, and control for the camouflage activities of all air force units in connection with the design, planning, and execution of their camouflage works. It fabricates and supplies camouflage materials from local sources and carries on experimentation for the application of camouflage techniques to local situations. It is charged with the indoctrination and training of all air force units in connection with camouflage policy, discipline, practices, and techniques.

■ 286. ENGINEER AVIATION TOPOGRAPHIC COMPANY.—This unit is organically assigned to appropriate elements of the air forces for the preparation and reproduction of special maps and charts required by air force units. It makes aeronautical and target charts and mosaics from aerial photographs taken by photographic groups of the air force. It works in conjunction with the photographic groups and normally is assigned on the basis of one per photo group. Mapping and reproduction equipment of the company is fully mobile.

■ 287. ENGINEER HEADQUARTERS COMPANY (AIR FORCES).—This company is attached to the engineer section of air force headquarters or to the engineer section of air service command headquarters. It operates under the air force engineer or air service command engineer. It performs necessary drafting, designing, surveying, planning, and reproduction, and furnishes camouflage assistance in connection with the activities of engineer aviation units.

CHAPTER 14

OPERATIONS OF ENGINEER UNITS WITH ARMY SERVICE FORCES

■ 288. GENERAL.—Many of the types of engineer units normally assigned to an army are also assigned to the Army Service Forces. The operations of these units, where they differ from those of like units assigned to the army, are described in this chapter. The operations of some units not normally assigned to the army or smaller units, but which are normally with the Army Service Forces, are also described.

■ 289. ENGINEER GENERAL SERVICE REGIMENT.—Engineer general service regiments with the Army Service Forces execute general engineer work similar to that done by these units in the army areas, but the work is usually of a more permanent nature. General service regiments with the Army Service Forces are employed frequently on task assignments in a single locality and are reinforced with special engineer units. They may construct or reconstruct cantonments, depots, base hospitals, railroads, ports, power stations, water-supply installations, and other facilities. Often a regiment will specialize in one type of construction work and will be moved from one such task to another of the same type. For example, one regiment may through experience become especially skilled in construction of railroads, another in putting up wooden buildings, and another in building bridges. Companies of the regiment may be assigned to independent engineer tasks widely separated.

■ 290. ENGINEER SPECIAL SERVICE REGIMENT.—a. Engineer special service regiments with the Army Service Forces are organized to undertake large construction and rehabilitation tasks that require a high degree of technical skill. A regiment may undertake a task with its own forces, but normally it is reinforced with local civilian labor to form a large construction force, or military units may be attached for this purpose.

b. Military tasks suitable for an engineer special service

regiment include clearing sunken ships from harbors; rehabilitating port and terminal facilities; rebuilding major utilities of destroyed cities; repairing and constructing major water-supply systems, power plants and transmission lines, railroads and railroad terminals; and constructing, repairing, and extending strategic highway routes.

c. An engineer special service regiment consists of a headquarters and service company, and two battalions of three companies each. Its strength is equal to that of the general service regiment, but it has an unusually large number of senior noncommissioned grades to supervise the civilian labor or attached military personnel, and to perform individual skilled tasks as required.

■ 291. SPECIAL ENGINEER UNITS.—Special engineer troops with Army Service Forces include principally units whose duties are connected with supply and maintenance. Statements concerning their operations are contained in succeeding paragraphs.

■ 292. ENGINEER DUMP TRUCK COMPANY.—Engineer dump truck companies with the Army Service Forces render assistance to general service regiments and other engineer units by furnishing transportation for movement of bulk engineer materials, on large engineer tasks such as the construction of airports, roads, and railroads. Each company has 44 dump trucks, and has other motorized vehicles sufficient for administration, reconnaissance, and second-echelon maintenance of its motor equipment. The company is completely motorized for simultaneous movement of all personnel, supplies, and equipment.

■ 293. ENGINEER HEAVY SHOP COMPANY.—This unit has the mission of accomplishing fourth echelon maintenance of all equipment for which the Corps of Engineers has maintenance responsibility. It normally takes over and operates an existing machine shop found in a theater of operations, although a special shop may be constructed where the required shop facilities cannot be located. The operations of a company are normally conducted in one locality. Equipment requiring fourth echelon maintenance work is drawn from depots, repaired, and returned where it becomes available for exchange

for unserviceable equipment in the hands of troops in the theater of operations. In cases where exchange of equipment is not practicable, it may be sent to the shop company directly from the units using it, or from maintenance companies, and returned to them when repaired.

■ 294. ENGINEER DEPOT COMPANY.—Engineer depot companies with the Army Service Forces are organized to operate engineer supply depots and other engineer supply points anywhere in the theater of operations. Normal missions of a company are to form the nucleus of a large engineer depot; to operate the engineer section of a general depot; or to operate a small engineer supply point. One depot company has personnel to handle a depot having up to 300,000 square feet of storage area.

a. In the operation of an engineer supply installation, the company is charged with receipt, inspection, storage, and issue of engineer supplies. It is not equipped with enough transportation to move simultaneously all personnel equipment and supplies. Its truck-mounted crane is employed for loading and unloading cars and trucks.

b. The general method of operation of depot companies is described in section III, chapter 10.

■ 295. ENGINEER PARTS SUPPLY COMPANY.—The primary mission of an engineer parts supply company is the operation of an engineer spare parts supply depot or other spare parts supply facility maintaining an adequate stock of spare parts and supplies for the maintenance of engineer equipment in theater of operations. The company may form part of an engineer depot, or may be the engineer section of a general depot, or may operate as an individual supply unit.

■ 296. ENGINEER EQUIPMENT COMPANY.—This unit acts as a connecting link between depots and engineer troops in making available heavy engineer equipment and the skilled personnel necessary for its operation. Its general mission is to train personnel in the operation, servicing, and repair of all types of heavy mechanical equipment employed by engineer units, and to assemble and put in operation the heavy mechanical equipment received at engineer depots. It is equipped as required with many types of heavy equipment

assigned to general engineer units and with many other types of heavy equipment such as rock crushers and bituminous paving machinery with which general engineer units are not equipped. General engineer units requiring additional heavy equipment may draw it from the equipment company. When the unit using it does not have qualified operators for the equipment, operators are furnished from the equipment company until operators from the unit itself can be trained. Normally the equipment company operates from one locality.

■ 297. ENGINEER FORESTRY BATTALION.—The engineer forestry battalion performs operations comparable to commercial logging and milling operations, utilizing available forest land to manufacture the required forest products. It consists of a headquarters and service company, and three or more engineer forestry companies. Each company is equipped with a three-unit skid-mounted portable sawmill capable of producing 1,200 to 2,500 board feet of lumber per hour. The mission of the unit is to manufacture and supply lumber to engineer depots for use anywhere in the theater of operations. A forestry company may operate separately. The battalion or units of it may acquire and operate existing lumber mills and facilities found in a theater of operations.

■ 298. ENGINEER BASE TOPOGRAPHIC BATTALIONS.—*a.* Engineer base topographic battalions are equipped to prepare and produce topographic maps in large quantity, by photogrammetric means, for the use of all military forces. These battalions are employed normally on long-range mapping programs designed to furnish complete and accurate maps of critical areas within the United States and in theaters of operations. In a theater of operations, a battalion normally is located near theater headquarters. A battalion may be required to reinforce an army topographic battalion. Base battalions recover and establish control points and carry forward horizontal and vertical control to army topographic units and aviation topographic companies.

b. A base battalion consists of a headquarters and service company, two survey companies, a photomapping company, and a reproduction company. The battalion sets up a base plant near headquarters or if a suitable plant exists in the

vicinity of headquarters, the battalion procures and operates it instead. Its operations being confined to a fixed locality and its mapping and reproducing equipment heavy, the battalion is relatively immobile.

■ 299. OTHER SPECIAL ENGINEER UNITS.—Many other types of special engineer units may be organized when required to meet special needs for engineer work for the Army Service Forces. Such units may include those organized to operate utilities, supervise tasks utilizing civilian labor, for port construction and repair, for producing and distributing petroleum products, or any other specialized work. They are discussed in the succeeding paragraphs.

■ 300. OIL WELL REHABILITATION GROUP.—An oil well rehabilitation group may be organized, trained, and equipped to make available for military needs petroleum products from recaptured oil fields. It is prepared to drill for, produce, and refine oil by simple direct processes.

■ 301. ENGINEER PETROLEUM DISTRIBUTION DETACHMENT.—An engineer petroleum distribution detachment may be organized, equipped, and trained to construct, maintain, and operate portable military pipe-line systems for the distribution of petroleum products.

■ 302. ENGINEER UTILITIES DETACHMENTS.—*a.* Engineer utilities detachments may be organized, equipped, and trained to operate the permanent utility installations in cantonments, camps, and permanent military posts.

b. In occupied areas it is expected that the enemy will have rendered the utilities of recaptured cities inoperative. Available engineer troops are employed to make repairs needed to place the utilities in serviceable condition for military requirements and later for the needs of the civilian population. The use of engineer troops for operation of utilities should be avoided whenever possible, but engineer troops may operate utilities until suitable civilians can replace them.

■ 303. ENGINEER PORT CONSTRUCTION AND PORT REPAIR GROUP.—Construction of a port is carried out according to

the port policy formulated by the theater of operations engineer and approved by the theater commander. The work of construction and repair of a port is undertaken by an engineer port construction and port repair group. The permanent nucleus of the group is a headquarters and headquarters company, staffed by commissioned experts and noncommissioned specialists to supervise the work and operate the special heavy construction equipment. Depending on the requirements of the task one or more of the following units will be attached: engineer general service regiment, engineer special service regiment, quartermaster truck company, quartermaster service battalion, quartermaster port battalion or civilian labor, and detachments of medical, signal, finance, and military police troops.

■ 304. ENGINEER PORT REPAIR SHIP COMPANY.—Port facilities and installations may be bombed by enemy aircraft and naval vessels, or be damaged by raiding parties landed by sea or air. An engineer port repair ship company consists of a repair ship and crew trained and equipped to remove disabled or sunken craft from along side docks and in berths. The ship is equipped with shops, diving and underwater cutting equipment, limited salvaging equipment, and is fitted with a 40-ton derrick. The ship carries also vital construction equipment and initial supplies to enable the port construction and port repair group to initiate repair or construction work immediately on arrival.

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