Chapter 7

Crossing Sites

SECTION I. CHARACTERISTICS

GENERAL

This section supplements the general descriptions of acceptable crossing sites in Chapters 2 and 3. Selection of crossing sites is primarily based on the –

- Existing situation and anticipated scheme of maneuver.
- Physical characteristics of the available sites, road networks, and surrounding terrain.
- Availability and capabilities of crossing means.
- Availability of engineer support.

Conflicts between tactical and technical requirements frequently occur. Commanders evaluate the factors bearing on the problem to determine the best overall solution.

CROSSING SITE SELECTION

Each crossing means, except air assault, requires a type of crossing site. They can be ford, assault boat, swim, raft, or bridge sites. Assault battalions use either a ford or an assault boat site (or sometimes a swim site) as an assault site.

Both the desired scheme of maneuver and available crossing means influence crossing-site selection. The division assigns a crossing area to each lead brigade. The brigade chooses which crossing sites to use within its area. When a particular site is important to the division's tactical concept, such as for movement of breakout forces, the division either coordinates with the affected brigade to open that bridge site or moves a bridge to that site once the brigade hands over the crossing area to the division.

Engineer intelligence identifies tentative locations supportable with the available crossing means. Brigade commanders select final crossing sites based on other tactical intelligence and their desired schemes of maneuver. Each site's physical characteristics, required engineer support, and available crossing means influence the decision, but tactical requirements are the most important.

The goal when selecting assault sites is to pick those that allow lead battalions to cross unopposed and rapidly seize far-shore lodgments. If unsuccessful at finding undefended crossing sites, lead battalions cross under threat fire while follow-on and overwatch units provide direct and indirect suppressive fires. Assault sites may or may not coincide with raft or bridge sites.

When selecting swim sites, the goal is to pick those that permit fighting vehicles to rapidly enter, swim across, and exit the water with minimum assistance.

The goal for raft and bridge sites is to pick those that support the greatest volume of vehicle traffic consistent with the scheme of maneuver. Raft and bridge sites are usually on or near major roads to minimize route preparation and maintenance. When the raft and bridge sites are located close together, the bridge site must be upstream of the raft site. This will avoid potential damage that may be caused by disabled rafts drifting into the bridge.

Regardless of the crossing means, each site needs engineers to cross early, reduce obstacles, and develop exit points on the far bank. River banks at otherwise suitable crossing sites often need work for access to the river. Most natural soil becomes unstable under heavy traffic. This condition worsens as fording, swimming, and rafting activities carry water onto it. The required engineer effort varies with soil type, crossing means, and vehicle density.

Natural conditions vary widely. Banks may require little preparation, or they maybe so restrictive that they limit feasible sites. Desirable site characteristics include –

- Minimum exposure to threat direct-fire weapons.
- Covered and concealed access to the river's edge.
- Gently sloping and firm banks allowing rapid entry and exit at multiple points.

Initial and subsequent entry points can vary. Available locations seldom have all the desired tactical and technical characteristics. The best routes through the crossing area normally cross the river at the technically best crossing sites. The best technical sites are not the best tactical sites because they are well known and are heavily defended by the threat. Forces initially crossing at less desirable locations are most likely to avoid detection and gain surprise. Moving laterally along the exit bank, they attack the flank or rear of threat units to seize the better crossing locations. Use of these sites then allows the most rapid buildup of combat power.

PLANNING

Planners need information of potential crossing sites to evaluate their compatibility with proposed crossing plans. Generally, planners need to know–

- Friendly and threat capabilities and probable COAs.
- Site capacity for crossing of troops, equipment, and supplies using various crossing means.
- Engineer support required to develop, improve, and maintain each site.

More specifically, planners need to know the –

- Bank, bottom, and water conditions of the river.
- Impact of forecast or historical seasonal weather conditions.
- Defensible terrain, cover and concealment, and natural or threat-emplaced obstacles on both sides of the river.
- Time and effort required to develop sites, assemble rafts, and construct bridges.
- Entry/exit routes and off-road trafficability.
- Road networks.
- Capability to deny observation, suppress fires, and provide site protection.

REQUIREMENTS

Entry and Exit

A desired feature of all sites is readily accessible entry/exit routes or paths on either bank. Approaches to banks are checked for their ability to support the requirements of the crossing element (width, slope, and trafficability) for wheeled and tracked vehicles. Covered and concealed approaches enhance surprise and survivability; however, multiple routes, free from obstruction, will increase crossing speed and flexibility. Exit-bank conditions often take precedence over entry-bank conditions until equipment and troops can be crossed to develop and improve the site. See *Figure 7-1* for depth requirements.

Routes and Approaches

Units use the following routes and approaches:

- Fords. Dismounted forces may use approaches with steep slopes and heavy vegetation, while vehicle fording requires paths or roads to approach fording sites.
- Assault or swim routes. Assault boat crossings may use more rugged approaches than amphibious vehicles.
- Rafts. Multiple approach routes to rafting sites permit relocation of rafting up- or downstream.
- Bridges. Bridge sites require developed road networks to sustain the crossing capacity.

Vehicles use the following routes and approaches:

- Wheeled vehicles. In general, wheeled vehicles require 3.5-meter path widths and 3.5 meters of overhead clearance. Dry, hard slopes of 33 percent can be negotiated; however, slopes less than 25 percent are desired.
- Tracked vehicles. Tracked vehicles require up to 4-meter path widths and 3.5 meters of overhead clearance. Tanks can climb 60-percent (31-degree) slopes on dry, hard surfaces; however, slopes less than 50 percent are desired.

Waiting Areas

Numerous waiting areas are required for equipment and troops preparing and protecting sites and for troops and vehicles preparing and/or waiting for crossing. These areas should be dispersed, provide cover and concealment, and be accessible to road networks near the sites.

River Conditions

In general, currents less than 1.5 meters per second (MPS) are desired. Narrow segments of the river decrease equipment requirements, crossing time, and exposure. However, resulting increased current velocities may offset any advantage.

OPERATION	Item	Draft (meters)	Remarks
Ford	Personnel	0.10	
	Wheeled Vehicle	0.75	
	Tracked Vehicle	1.20	
Assault/Swim	M113 (APC)	1.50	Sufficient depth for operation of boats or vehicles to be used.
	M548	2.00	
	M2	1.07	
Raft/Bridge	Power boat (27 feet)	1.00	Need deep water close to the bank to preclude grounding of the raft or bridge.
	LTR	0.60 *	
	M4T6	0.75 *	*Power boat draft may govern depth.
	Ribbon	0.60 *	

Figure 7-1. Depth requirements

Banks

Ford banks may be steep and rugged for dismounted troops. Vehicles require less than 33 percent slopes and firm soil conditions. Assault or swim banks may be steep when using assault boats for dismounted troops. Amphibious vehicles may be able to enter over low, l-meter vertical banks, but they require sloped exits. Vertical banks of approximately 1 to 2 meters maybe accommodated by bridge or raft ramps (see *Figure 7-2).* Vertical bank heights for bridges using the equipment listed in the figure do not change for light tactical raft (LTR) or ribbon bridges. For M4T6 and Class 60, the height of the bridge deck can be adjusted to accept a difference in bank heights; however, the limiting factor may become the longitudinal slope of the bridge.

Equipment	Ramp Articulation (Raft)	
	UP	DOWN
LTR	1.0 meter*	0.48 meter*
M4T6	not adjustable	
Class 60	not adjustable	
Ribbon	1.0 meter**	

*This is true when using articulators.
**An approach ramp of 7 feet long provides extra roadway or loading and off-loading vehicles.

Figure 7-2. Bank requirements

Bottoms

Ford bottoms must be free from obstacles, firm, and uniform. Riverbeds may be improved with rock fill or grading equipment. Guide stakes ease crossing. Assault or swim site bottoms must be free from obstructions that interfere with boats or tracks of amphibious vehicles. Raft sites must be free from obstructions that could interfere with boat operations. Bridges emplaced for lengthy periods (4 hours or more) or in strong currents require suitable riverbeds for anchorage. Divers from theater army may be used to conduct river-bottom reconnaissance to ensure the success of the operation.

Threat Situation

Sites masked from threat observation enhance surprise and survivability. The use of existing sites reduces preparation time but requires caution in that the threat may have emplaced obstacles and registered artillery on the site.

SITE ANALYSIS

A ground reconnaissance refines and confirms information gathered from other sources. *(FM 5-36* and *TC 5-210* contain details for the conduct and reporting of site reconnaissance.) From these and other detailed reports, planners may develop charts or overlays to compare alternate sites. Unit SOPs may prescribe specific comparative methods. See *Figure 7-3* for an example.

Bank Preparation Time

- Describe bank height, slope, and stability.
- List time and effort to overcome significant natural and enemy-emplaced obstacles.
- Include day, night, or other reduced-visibility constraints.

River Conditions

- Specify width, depth, velocity, and bottom conditions as appropriate.
- Include variations or unique factors (such as sandbars, turbulence, or depth at bank).

Vegetation

- List space suitable for work sites and assembly areas and available cover/concealment.

Full Crossing Rate

- Describe foot, wheeled, and tracked movement capability on roads, trails, and cross-country
- Describe maximum crossing rate for fording, swimming, or rafting.

Rafting

- Include overall assessment of crossing-site potential.

Figure 7-3. Crossing-site requirements

FIELD CALCULATIONS

Some common relationships and expedients useful during a ground reconnaissance include determining unit measures of speed, measuring river velocity, determining slopes and degrees, measuring river width, and calculating downstream drift.

Determining Unit Measures of Speed

Correlating the desired maximum stream velocity of 1.5 MPS with a familiar comparative unit of measure may help estimate current. The quick-time march rate of 120 steps per minute, with a 30-inch step, equates to 1.52 MPS. Other approximate correlations of 1.5 MPS include —

- 5 feet per second (fps)
- 3.5 miles per hour (mph)
- 5.5 kilometers per hour (kph)

Measuring River Velocity

The current of the river is critical to effective and safe operation. A reasonable estimation involves measuring a distance along the riverbank and noting the time a floating object takes to travel the same distance. Dividing the distance by the time provides the water's speed (see *Figure 7-4*).

Determining Slopes and Degrees

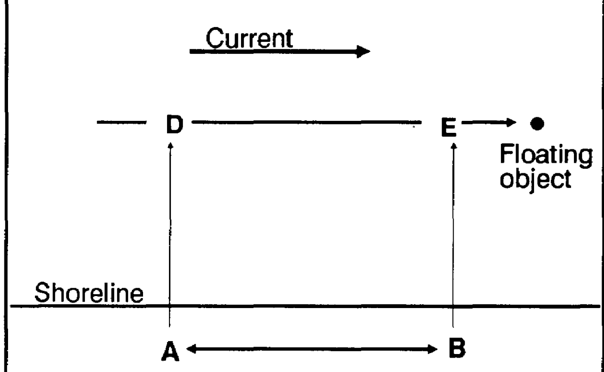
The slope of terrain is significant (for example, slopes of 7 percent or more slow movement and may require vehicles to operate in a lower gear). Slope, usually expressed as a percentage, is the amount of change in elevation (rise or fall) over a ground (horizontal) distance (see *Figure 7-5*).

Vehicle capabilities to climb or descend terrain are commonly expressed in percent of slope. For example, tanks can negotiate slopes of 60 percent, based on ideal conditions such as dry, hard surfaces. Rocks, stumps, and loose soil degrade capabilities. Wheeled vehicles are generally limited to a maximum slope of 33 percent.

Means to determine percent of slope include –

- Clinometers. These instruments measure percent of slope and are organic to most engineer units.
- Maps. In this method, one must first measure the horizontal distance along the desired path, then determine the difference in elevation between the starting and ending points of the path. The next step is to ensure that both figures are the same unit of measure (such as feet or meters). The final step is to divide the elevation (rise) by the distance (run) and multiply the result by 100 to get percent of slope (see *Figure 7-6*).
- Line of sight and pace. This method uses eye-level height above ground (usually from 1.5 to 1.75 meters) and length of standard pace (usually 0.75 meter). While standing at the bottom of the slope, the individual picks a spot on the slope while keeping his eyes level. He paces the distance and repeats the procedure at each spot. Adding the vertical and horizontal distances separately provides the total rise and run.

Slope may also be expressed in degrees; however, this provides angular measurements. The method is not commonly used because the relationships are more

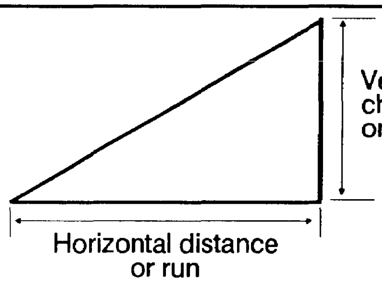


Example:

- Measure **AB**
- Throw a stick or other floating object upstream of the start point **D**.
- Record the time the object floats from **D** to **E**.

$$\text{Current} = \frac{\text{Distance } \mathbf{AB} \text{ (meters)}}{\text{Time } \mathbf{DE} \text{(seconds)}}$$

Figure 7-4. Measuring current velocity



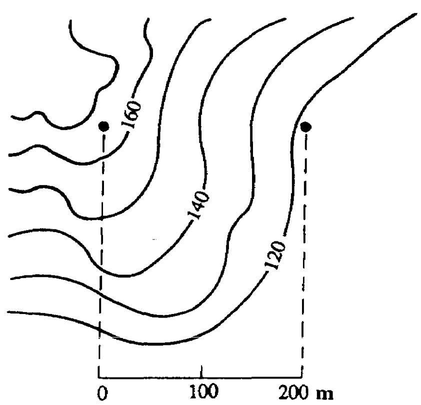
Formula:

Rise divided by the run multiplied by 100 equals the percent of slope.

(% slope = rise/run x 100)

Note: Rise and run are expressed in the same unit of measure (feet or meters).

Figure 7-5. Slope calculation



Rise = 165-120 = 45 meters
Run = 200 meters

$$\% \text{ Slope} = \frac{45}{200} \times 100 = 22.5\%$$

Figure 7-6. Terrain slope

complex than desired for field use. *Figure 7-7* lists some relationships of percent and degree of slope.

SLOPE	DEGREES
100%	45
60%	31
40%	22
20%	11

Figure 7-7. Relationship of slopes and degrees

Measuring River Width

A field-expedient means of measuring river width is with a compass. While standing at the waterline, sight on a point on the opposite side. Note the magnetic azimuth. Move upstream or downstream until the azimuth to the point on the opposite bank is 45 degrees different than the original reading. The distance from the original to the final point of observation is equal to the stream width (see *Figure 7-8).*

Calculating Downstream Drift

The river current causes all surface craft to drift downstream. Each vehicle has a different formula for calculating downstream drift. Amphibious vehicles and assault boats drift more than powered boats and rafts; the latter have a greater capability to negate the effect of river velocity by applying more power.

Amphibious vehicles and nonpowered assault boats are generally limited to water speeds of 1.5 to 2 MPS and 1 MPS respectively (see *Figure 7-9).*

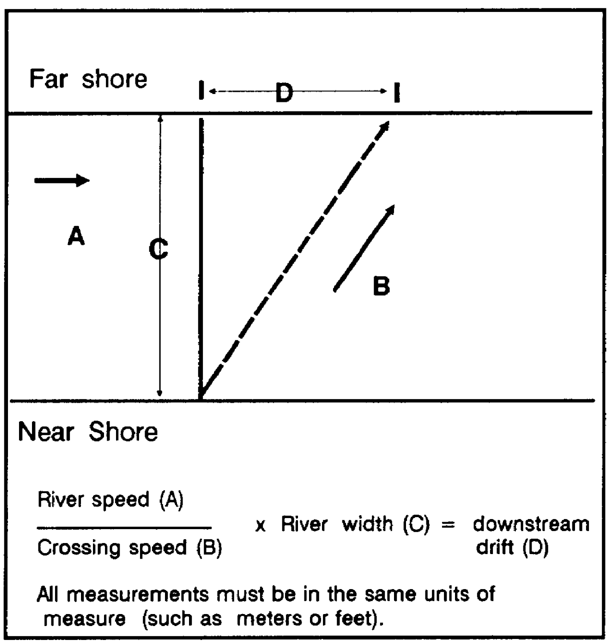


Figure 7-9. Amphibious drift

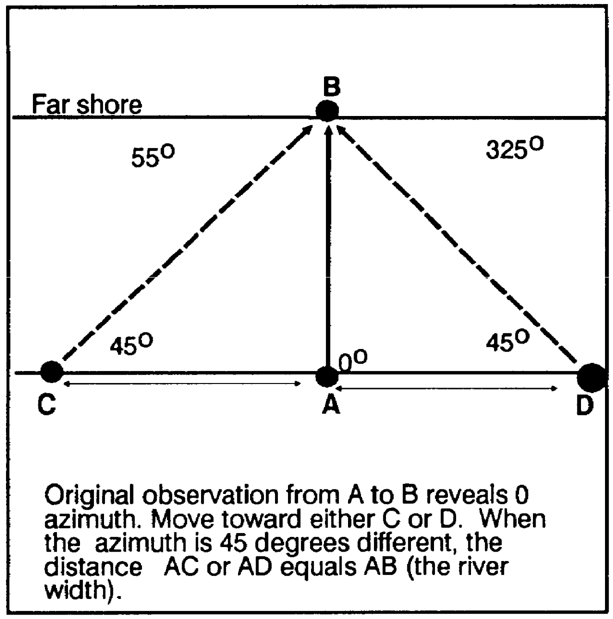


Figure 7-8. River width

Crossings with amphibious vehicles and pneumatic boats must compensate for the effect of river current. The following examples show methods:

Example 1. Entry is usually made upstream of the desired exit point. The vehicle or boat is aligned, or aimed, straight across the river, creating a head-on orientation that is perpendicular to the exit bank. However, the current produces a sideslip, downstream forward movement (see *Figure 7-10).* This technique requires operator training in continual adjustment to reach the objective point on the exit bank. This technique results in a uniform crossing rate in the least amount of time and is usually the desired technique.

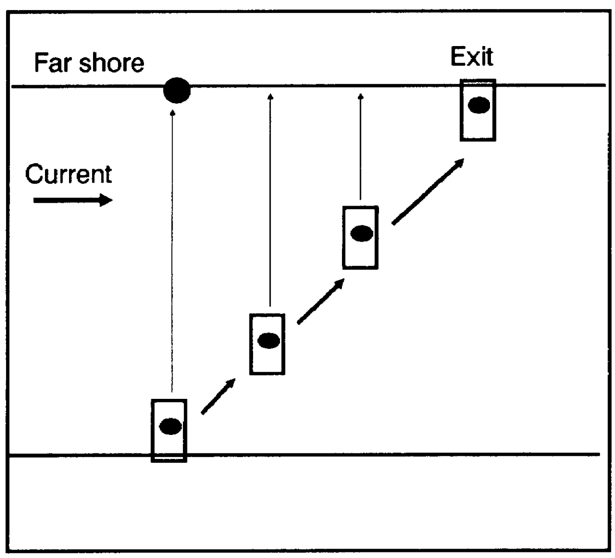


Figure 7-10. Downstream sideslip

Example 2. If the operator continues to aim the vehicle at the desired exit point, the orientation of the craft at the exit point will approximate an upstream heading. The craft path is an arc in proportion to the speed of the river (see *Figure 7-11).*

Example 3. To exit at a point directly across from the entry point requires an upstream heading to compensate for the river's speed (see *Figure 7-12).*

In all three examples, the craft speed relative to the river speed is constant, assuming the engine revolutions per minute (RPM) or paddling rate remains constant.

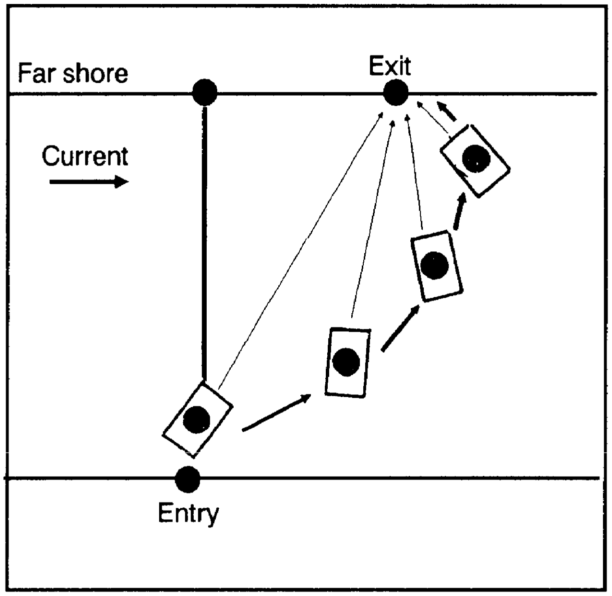


Figure 7-11. Constant aim point

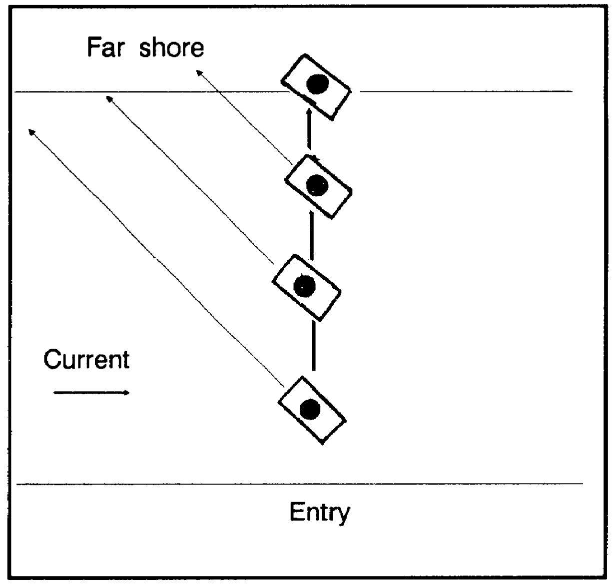


Figure 7-12. Constant heading

Terrain conditions may restrict the location of entry and/or exit locations. Threat situations may require alternate techniques. For example, when aiming at the downstream exit point, the craft moves at a greater speed relative to the banks after entry than it does as it nears the exit. The cause is the river current speed. Use of this technique may be favored when the threat has better observation of the entry bank than the exit bank. Watercraft moving fast and at a changing rate are more difficult to engage effectively.

Section II. Operations

RAFTS

Sites

Assault battalions seize a far-shore lodgement and then clear in zone to secure the crossing sites from direct fire. Quick reinforcement with armored fighting vehicles is critical when the initial assault is dismounted. They have the weapons needed to defeat determined threat counterattacks and can rapidly move units to subsequent objectives. Fighting vehicles cross by swimming or rafting.

Given the vital need to rapidly build combat power on the far shore, the lead brigades should swim fighting vehicles of follow-on battalions whenever practical to save rafts for tanks.

Rafts are usually the initial means for crossing non-swimming vehicles, particularly tanks, on wide, unfordable rivers. It maybe possible to bridge immediately after the assault across the river phase; however, rafting is normally first because —

- Rafts are less vulnerable to threat air and indirect fire due to their size and maneuverability.
- Rafts are quicker to assemble.
- Rafts offer more flexibility in operation, particularly in site selection and subsequent movement between sites.
- Rafts can use existing road nets and banks where access and exit routes are not aligned opposite each other.

Raft assembly begins on order, not according to a preplanned schedule, even though the crossing plan has an estimated start time. Unless the division commander directs otherwise, the brigade commander, advised by his engineer, decides when to begin rafting. This is always after eliminating threat direct fire on the site and usually after neutralizing observed indirect fire. (Massed threat indirect fire can cover an entire raft site.) The force neutralizes observed indirect fire by suppressing it and obscuring the crossing sites.

The brigade commander also decides when bank preparation can begin, or he may delegate this decision to his engineer. This is a matter of judgement, based on the estimated time required to secure the area. Extra time and effort initially spent on bank preparation avoids interruptions for maintenance later while rafting is in progress.

The key to rapid and effective bank preparation is good engineer reconnaissance, which permits engineers to arrive at the site early, organized and equipped to perform specific tasks to improve the approach. The same is true on the exit bank. Poor bank conditions require early priority for raft movement of engineer equipment across the river. Time spent preparing the exit banks before passing heavy traffic greatly reduces maintenance of the crossing site and speeds force buildup later. Two entry and exit points per centerline make it possible to alternately use one while maintaining the other.

Each lead brigade should have at least two raft sites, each of which has one to three raft centerlines. Terrain, routes, and the tactical plan determine their location. However, they should not be closer together than 300 meters to avoid congestion and the risk that threat artillery concentrations will impact on more than one site during a barrage. Engineers prepare alternate sites as soon as possible to permit relocation in case of threat action or bank deterioration.

Additional control measures are necessary on the river and bank approaches at night. Chemical lights and other discreet markers help drivers find and load onto rafts. Rehearsals include divers, who practice driving on and off of rafts at night. Engineers may need additional communication and night-vision devices to control their operation.

Raft sites include centerlines crossing the river where the rafts operate, the approaches to the centerlines on each shore, and the control and operation structure necessary to conduct rafting operations. *Figure 7-13* illustrates a typical raft site with three centerlines.

An engineer company commander (normally from the bridge company) is the crossing-site commander. He is in command of crossing-site activities from the call-forward area to the far-shore attack position. He

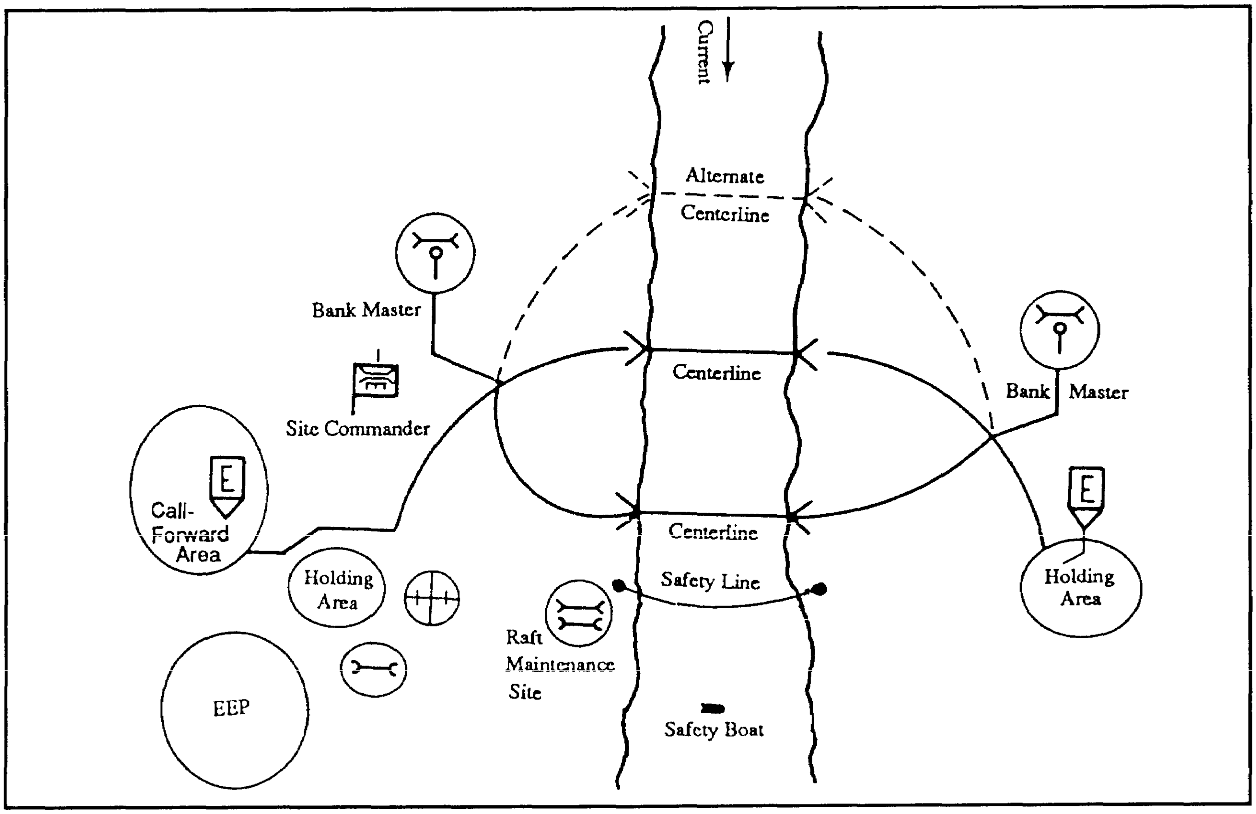


Figure 7-13. Raft site

reports to the CAE. His company headquarters coordinates the following site activities:

- Site layout.
- Raft assembly, operation, and maintenance.
- Opening and closing of raft centerlines.
- Layout of the call-forward area, operation of the ERP, and organization of crossing units into raft loads.
- Route marking from the call-forward area to raft centerlines.
- Movement of raft loads from the call-forward area to raft centerlines, across the river, and into the far-shore attack position.
- Bank and route maintenance.
- Vehicle movement within the site.
- Movement of return traffic from the far shore.
- Liaison from the crossing unit.

The CAE provides corps combat engineers, normally a platoon or more, to the crossing-site commander to use for ERPs, route and bank maintenance, and other tasks beyond the capability of the bridge company.

The CSC designates an engineer bank master, who maintains traffic flow as directed by the CSC or his headquarters. His functions are to –

- Tell the ERP at the call-forward area when to send raft loads to the river.
- Direct each raft load to a centerline.
- Divert vehicles off the road when necessary to a maintenance recovery point, casualty collection point, or small holding area.

Each raft site has one to three active centerlines spaced 100 to 300 meters apart. The 100-meter minimum distance avoids collisions between rafts on adjacent centerlines and reduces the effects of artillery, while spacing centerlines farther than 300 meters apart stretches the ability of one unit to control both land approaches and water operations. Each crossing site has at least one alternate centerline. The CSC switches to the alternate centerline when necessary due to threat fire or bank maintenance.

A platoon leader of the bridge company is in charge of each centerline. A centerline has an embarkation point on the near bank, a debarkation point on the far bank, and rafts operating between these two points. The number of rafts on a centerline depends on river width and unit control. Appendix B gives the number of rafts per centerline based on river width. Maintaining bridge unit integrity on centerlines and crossing sites is critical. It simplifies maintenance and operation of rafts and significantly improves control on the water, as all raft commanders and boat operators have trained together. As six rafts on one centerline are within one bridge company's capability, this is the normal maximum employed. On any centerline, rafts must be the same type and configuration.

Centerlines are marked to guide vehicles approaching and leaving the water and to guide rafts to the correct landing points. Marker stakes or panels are used during daylight, and dim lights (covered flashlights or chemical lights) are used at night (see *Figure 7-14).* Markers include the following:

- Raft guide markers, at a 45-degree angle upstream, guide the raft to the embarkation or debarkation point. The two markers are 3 feet apart, and the marker farthest from the river is 2 feet higher than the other. The raft has the correct approach to the bank when the markers appear to be in a straight line, with one above the other.
- Raft landing markers depict the left and right limits of the embarkation or debarkation point.
- Vehicle guide markers align raft loads with the raft and are visible to both the raft and the vehicles.

Each raft site contains at least one safety boat, normally a bridge-erection boat, for troop and equipment recovery. The bridge company provides the crew of the safety boat, including the boat operator, the boat commander, medic, and lifeguard (two, if possible), The lifeguard-qualified swimmer does not wear boots or load-bearing equipment (LBE). The safety boat also has a float with an attached line for rescuing troops in the water, a boat hook, rocket-propelled lifelines (if available), and night-vision goggles for at least the boat commander. It has a radio on the bridge company net. The safety boat maintains its station 50 meters downstream of the safety line.

When possible, a safety line should be run across the river 100 meters downstream from the last centerline, This line is fastened to the banks and kept afloat by life jackets attached to the line every 30 meters. This rope acts as a catch rope for troops who may fall overboard during rafting operations.

Each crossing site requires an EEP located where the equipment will have easy access to the crossing site. Traffic between the EEP and the riverbank should use a separate route to avoid congestion with the crossing.

Each raft site requires a place along the friendly shore, downstream of the centerlines, for immediate raft repairs, The maintenance area requires an access point to the river for removal and launching of bays and boats. Additional equipment desired at the maintenance area includes –

- A bridge boat to move damaged bays and serve as a spare boat.

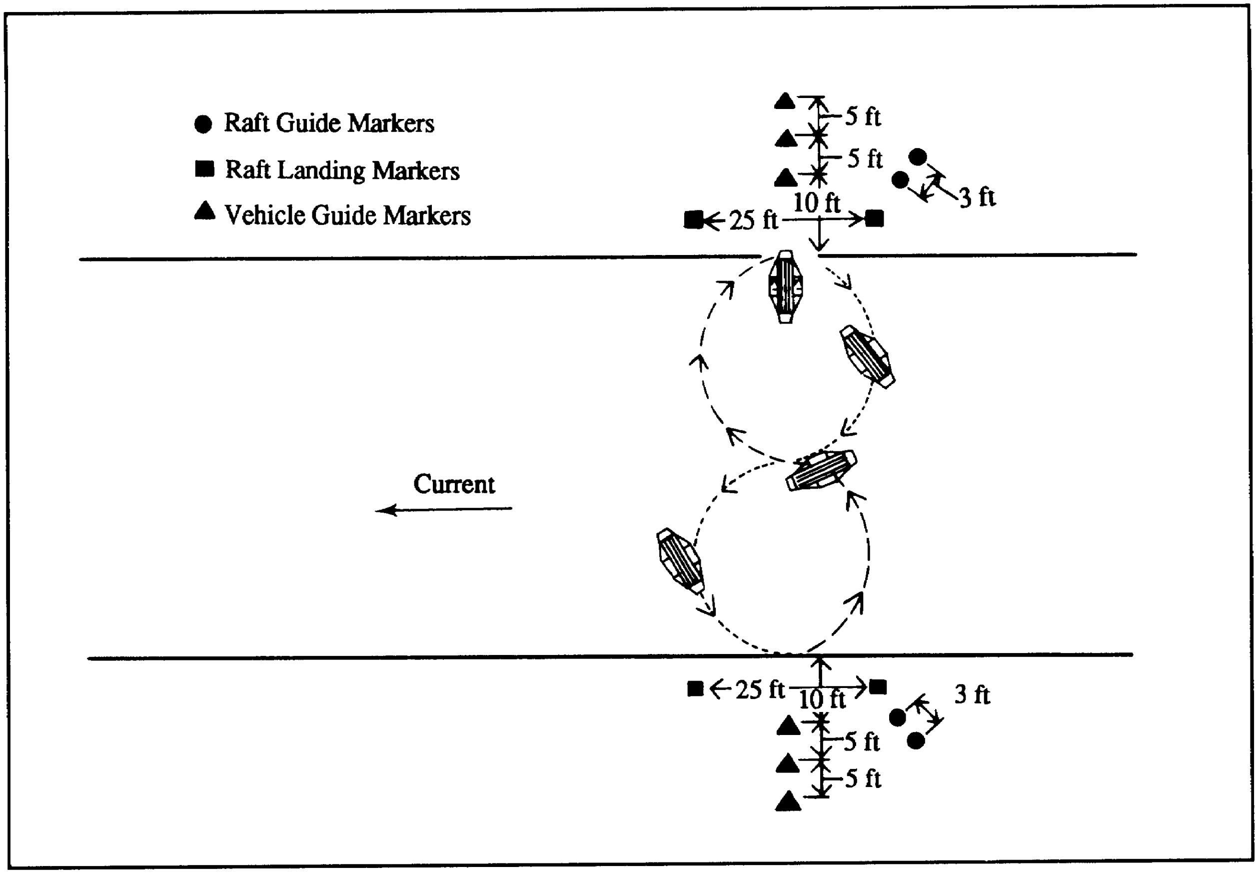


Figure 7-14. Centerline marking and operation

- A crane to remove nonrepairable equipment from the water.
- A bridge truck to transport damaged equipment to the EEP.
- A heavy-expanded mobility tactical truck (HEMMT).
- One interior and exterior bay to use as replacement parts.

The maintenance area is continuously manned with—

- Two mechanics with tool boxes.
- Two fuel handlers.
- Operators of the various pieces of equipment.
- A site supervisor.

Operation

When ordered to begin rafting, the CSC directs the ERP at the call-forward area to begin sending raft loads forward. Units proceed from a staging area to the call-forward area, where engineers at the ERP organize them into raft loads and send them down to the river. Any points along the route that may cause confusion, such as intersections, are either manned with a guide or are marked to ensure that the vehicles do not get lost. Once a raft load nears the river, the bank master directs it to the appropriate centerline. The bank master controls the flow of traffic to the centerlines to ensure that there is a smooth flow of traffic and that centerlines are neither congested nor underused. He establishes the timing required so that raft loads leave the call-forward area and match up with a returning empty raft,

When a raft load reaches the river bank, it is met by an engineer centerline guide. He stops the raft load 10 feet from the edge of the water and holds it there for the raft commander. The raft commander guides the vehicles of the raft load onto the raft. The raft crew chocks the vehicles and issues life jackets to passengers, who dismount from their vehicles (with the exception of the operator and vehicle commander), don life jackets, and move to the rear of the vehicles. Upon reaching the debarkation point, the raft crew guides the vehicles off the raft, collects the life jackets from the passengers, and directs them off the raft. After the raft load debarks, the raft commander checks with the centerline guide for any return vehicles and returns to the embarkation point.

Once on the far shore, the centerline guide directs the raft load to the far-shore attack position, where the unit re-forms.

Maintenance and Refueling

During raft operations, rafts require stops for refueling, preventive maintenance, and minor repairs. The efficiency of the crossing depends on all rafts having enough fuel and on minimal lost time for refueling and normal maintenance. This efficiency requires the bridge company to intensely manage raft maintenance and to operate the maintenance area like a pit crew in an automobile race. When directed, a raft pulls off the centerline and moves to the crossing-site maintenance area.

With the raft secured, the crew begins refueling and maintenance operations. Mechanics assess and repair any minor damages to the raft and the boats. Fuel handlers run fuel lines from the fuel HEMMT to both bridge boats and fuel them simultaneously. If no major deficiencies are identified, the entire process requires 20 minutes. If major deficiencies are identified, the damaged equipment is removed from the raft and replaced with a spare. The damaged equipment will then be removed from the water and sent back to the EEP for repair. When finished, the raft returns to its centerline and another raft is directed in for maintenance and refueling.

Since the maintenance and refueling operation is continuous and requires the removal of a raft from the operation for up to 30 minutes, it is important to account for this reduction in capabilities when planning the operation. As a general rule, it is unnecessary to refuel for the first two hours after rafting begins. Once raft maintenance and refueling begin, one of the six rafts in each bridge company is unavailable for carrying vehicles across the river.

In the event that a raft becomes damaged and needs immediate repair, the raft commander moves the raft to the maintenance area. If the raft loses a boat and cannot make it to the maintenance area without assistance, the raft commander contacts the maintenance supervisor, who sends the maintenance boat out to assist. If the raft is still carrying a load, the raft commander decides which bank he will disembark the load on. Once in the maintenance area, mechanics determine the extent of the damage. If the damage requires significant repair, the damaged equipment will be removed and replaced with a spare. Lengthy equipment repairs are done at the EEP.

BRIDGES

General

Bridges replace or supplement rafts once threat-observed indirect fire is eliminated. Each lead brigade should convert at least one raft site to a bridge site as soon as possible, while keeping other raft sites in operation until a second bridge is in place. Bridges have greater traffic flow rates than rafts. Ribbon is the preferred initial bridge, since it is faster to assemble and easier to move than other types. Once assembled, all float bridges have a crossing rate of 200 vehicles per hour, with vehicle speed at 15 miles per hour. As with rafts, bridge assembly begins on order, not according to a preplanned schedule. Since vehicles cross rivers much faster on bridges than on rafts, early bridge assembly is desirable but must be weighed against the risk that the threat can still bring indirect fires down on an immobile bridge. The bridgehead force brigade commander decides when to begin, with advice from his engineer. He may delegate this decision to his engineer.

Bridges need protection. Air defense, counterfires, and ground-security elements are necessary to defeat threat attacks. Booms on the river protect bridges from collision damage caused by floating and submerged objects.

Bridges are vulnerable to threat long-range artillery fire and air attack even after the assault clears threat forces from the exit bank. For this reason, ribbon bridges operate for a limited period of time, normally two hours, before the engineer bridge units break them apart and move them to other sites. When the division uses this pulse-bridging tactic, its units wait to cross in staging areas and surge across when bridges are in place.

Threat air superiority over the river may prohibit bridge assembly. Sustained threat air attack forces engineers to break established float bridges into rafts. This minimizes destruction of scarce bridge assets yet enables the crossing to continue, though at a slower pace. Engineers prepare alternate sites and position spare equipment nearby in case of threat action.

As the danger from threat action lessens, engineers use the more slowly assembled LOC, M4T6, and Class 60 bridges to augment and then replace the tactical bridges (ribbon or armored vehicle launched bridge (AVLB)). They do this as soon as possible to move ribbon bridges forward on other crossing operations.

Threat bridges captured by the lead brigades are a bonus and speed the crossing. Engineers with the lead brigades neutralize explosive devices and reinforce weak or damaged bridge structures. Commanders rarely base the success of an operation solely on the seizure of intact bridges.

Site Organization

A bridging operation requires a continuous traffic flow to the river. Units must be quickly briefed and moved to the crossing site. To accomplish this, units receive briefings in the staging areas from the traffic-control personnel. There is no intermediate call-forward area. In order to control crossing vehicles, the engineers from the bridge unit set up an ERP at the bridge access points on each side of the river. These engineers guide vehicles onto and across the bridge, ensure proper speed and spacing of vehicles on the bridge, and prevent vehicles too heavy for the bridge from trying to cross. A recovery team is stationed on the far shore to remove any damaged vehicles from the bridge. The recovery team consists of a medium or heavy recovery vehicle and crew, with sufficient winch cable to reach across the bridge. A typical site setup is shown in *Figure 7-15.*

Any method can be used to mark the route to the bridge, as long as markers are visible to the operators of the vehicles and are masked to observation from above. As the vehicle approaches the bridge edge, markers are spaced 100 feet apart to assist operators in visualizing the required vehicle interval on the bridge.

Operations

At night and during limited visibility, the left and right limits of the bridge treadway are marked with chemical lights to prevent them from driving over the side of the bridge and to cause them to maintain crossing speed.

Actions Under Fire

If the unit comes under fire while on the bridge, those vehicles on the bridge continue moving to the other side and leave the area. Vehicles that are not yet on the bridge stop and go into a herringbone formation or take up concealed positions. Once all vehicles have cleared the bridge, the bridge crew will break the bridge into rafts and disperse them to reduce vulnerability to incoming fire.

Vehicle Recovery

If a vehicle breaks down on the bridge, the bridge crew will immediately attach a winch cable from the far side and drag the vehicle off the bridge. The recovery vehicle will not move onto the bridge and tow the disabled vehicle off, since the critical requirement is to clear the bridge and maintain traffic flow, loss of the vehicle is far less important.

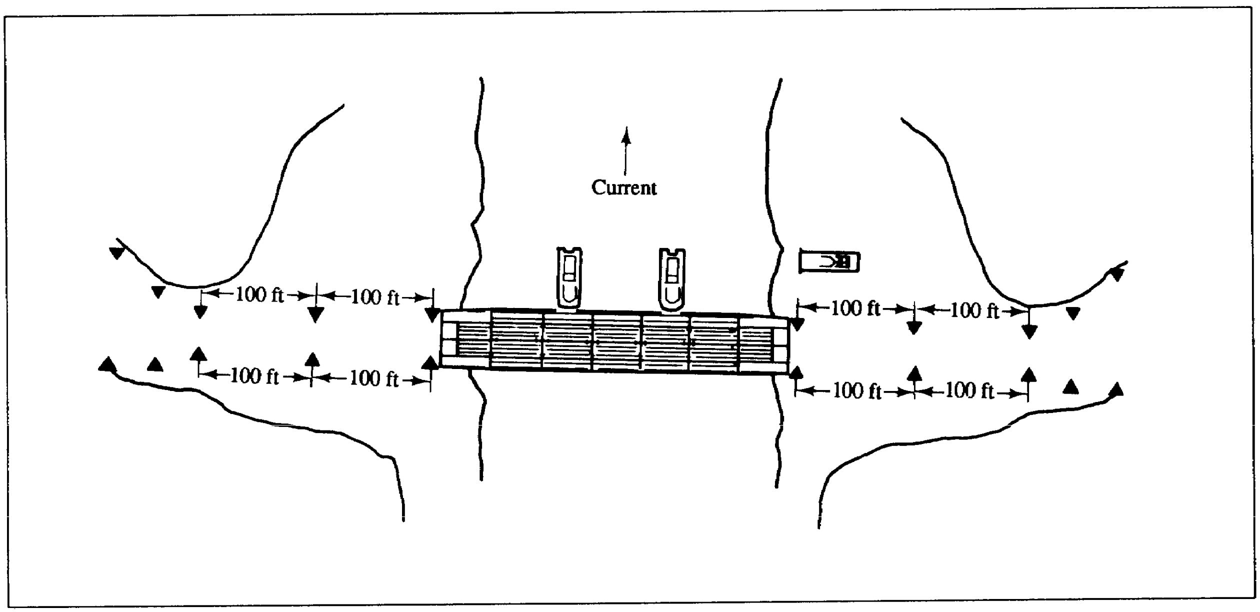


Figure 7-15. Bridge crossing site