Appendix C

Obstacle Reduction Techniques

Obstacle reduction techniques described in this appendix use fielded or soon-to-be-fielded equipment. Mine rollers, track-width mine plows, M9 ACEs, and the cleared lane marking system (CLAMS) will enhance fores breaching today with MICLICs, grappling hooks, hand-emplaced explosives, bangalore torpedoes, bayonets, probes, mine detectors, earth-moving plows, hand-emplaced minefield marking systems (HEMMS), and field expedient marking. Engineers and breaching equipment operators rehearse and practice these reduction techniques and apply them as part of the breaching actions of the company teams to which they are attached. These techniques are the most common, but many others are possible.

Breach forces will seldom employ only one technique against any single obstacle. A variety of techniques employed simultaneously complicates the breaching countermeasure problem for the defender and provides an additional margin for a successful breach. Attempting several simultaneous breaches also reduces the effects of covering fires, which reduces casualties and increases the probability of successfully producing a lane. Trying a technique, failing, then trying a second one is a trap that leads to defeat. However, when explosive techniques are employed, the breather must be sure that dismounted engineers or infantry using other techniques are clear of the area.

MOUNTED EXPLOSIVE TECHNIQUES

Mounted explosive techniques allow the attacker to quickly breach an obstacle in minimal time and with minimal risk to personnel and equipment.The MICLIC and CEV are the primary tools for mounted-explosive obstacle reduction. However, the commander must understand the limitations of these techniques and their tactical impact. While they provide a quick breach, these assets are only effective against certain types of obstacles. The lane size and reliability may also vary greatly.

Mine-Clearing Line Charge

The MICLIC is a rocket-propelled, explosive line charge used primarily to reduce minefield containing single-pulse, pressure-activated AT mines and mechanically activated AP mines. It clears a path 100 meters long by 14 meters wide. Within this path, all pressure-activated mines will be destroyed, with the exception of some deeply buried mines along a narrow "skip zone." Mines containing magnetic or other nonpressure-sensitive fuses may escape destruction from overpressure but will usually be uncovered and blown sideways out of the lane. The MICLIC may have reduced effectiveness if employed across broken or wooded terrain. After it has been fired, the MICLIC leaves an obvious rut along the center of the cleared path.

The MICLIC can be initiated from within the towing vehicle without exposing soldiers and has a 62-meter standoff distance from launcher to detonation point. It is mounted on a rubber-tired trailer and may be towed into position by a fighting vehicle or other prime mover. The towing vehicle must be identified well before the mission rehearsals and dedicated to that task. The vehicle operator must train to proficiency in preparing and deploying the MICLIC. This includes critical skills such as estimating the 62-meter standoff and driving his vehicle to correctly aim the charge. The MICLIC launcher can be reloaded in 20 minutes by an experienced crew. The launcher and the towing vehicle must move to a reload point after firing the first MICLIC. Equipment capable of lifting the loaded demolition charge container, which weighs about 2,500 pounds (1,134 kilograms), must be available at the reload site. MICLICs have also been mounted and fired from AVLB decks, with the bridge down loaded, and from the beds of transport vehicles.

The MICLIC is designed to detonate mines along a 14-meter-wide path (see *Figure C-1, page C-2).* However, testing has shown that some mines located from .75 to 1.5 meters either side of the charge may not detonate. Within this zone, the MICLIC detonates 92 to 95 percent of mines that are surface-laid or buried up to 1 inch. Mines buried deeper are less likely to detonate. Roofing vehicles will eliminate any mines in the skip zone by keeping the center of the vehicle over the cleared path centerline.

The number of MICLICs needed to clear a single lane through a minefield depends directly on the minefield depth. Minefield greater than 100 meters deep require two or more MICLICs; minefield less than 100 meters require only one. As discussed in *Appendix A*, Soviet minefields can be from 60 to 120 meters deep.

However, the exact limits and depth of an enemy minefield are seldom known prior to the breach. This is particularly true when the situation is unclear and the minefield is encountered simultaneously with enemy contact. The first and only indication that the unit is in a minefield may be when a vehicle encounters a mine. The leading edge of the minefield still may be uncertain, since the vehicle could have hit a mine in an interior row. Therefore, there are two basic drills for MICLIC employment: Deploy a MICLIC to Breach a

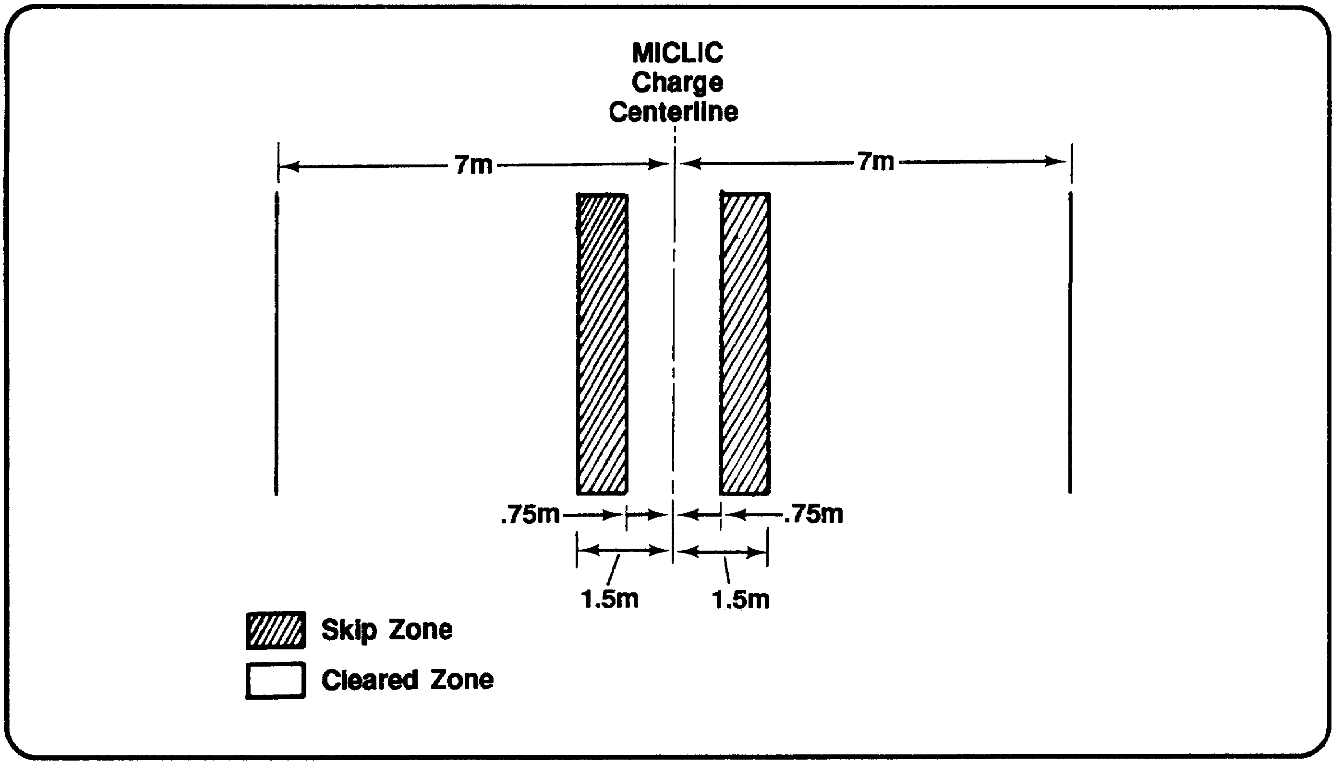


Figure C-1. MICLIC skip zones.

Minefield Less than 100 Meters Deep, and Deploy a MICLIC to Breach a Minefield of Uncertain Depth or Greater than 100 Meters.

Clearing a lane through a minefield less than 100 meters deep requires one MICLIC (see *Figure C-2).* If time permits, the leading edge of the minefield is identified and confirmed by reconnaissance. The MICLIC is deployed from a minimum standoff distance of 62 meters from the leading edge of the minefield. This distance is necessary to allow for the 62 meters of inert line charge and maximizes the amount of actual charge in the minefield.

Clearing through a minefield of uncertain depth or greater than 100 meters requires two or more MICLICs (see *Figure C-3, page C-4*. The first MICLIC is deployed 100 meters from the identified leading edge or stricken vehicle (if no leading edge can be identified). Once the first MICLIC is detonated a second MICLIC moves 25 meters into the path formed by the first and fires its charge. This extends the lane an additional *87* meters. Additional MICLICs are used for minefields of extreme depth, and each one moves down the lane 25 meters into the path created by the previous charge.

Combat Engineer Vehicle 165-Millimeter Demolition Gun

The CEV 165-millimeter demolition gun fires a large high-explosive plastic (HEP) round to a range of 925 meters. The round contains a "squashable" plastic explosive and employs a base-mounted fuse that it detonates on impact against hard targets. It is designed to be particularly effective against concrete obstacles and masonry buildings. However, it is also effective against armored vehicles, bunkers, bridge abutments, and earthen embankments. It is the most useful breaching device in the force against nonexplosive obstacles and dug-in defenders.

The demolition gun is normally used well within its maximum effective range. Rapid adjustment of fire is possible because of the slow velocity of the projectile. Generally, the gunner has relayed the reloaded gun on the target before the projectile impacts, allowing a rapid-following shot using burst-on-target techniques. The CEV commander assesses the number of rounds required to destroy the target before he engages. As a rule, two shots are fired for effect against a target unless the commander observes target destruction and commands that firing cease. Normally, the CEV will not fire more than three rounds from one position (approximately a 45-second engagement). The vehicle driver will automatically move the vehicle to a preselected supplemental firing position after the second round is fired unless he hears "adjust fire"; in which case, he waits until after the third round.

The objective of 165-millimeter fire against concrete or masonry obstacles is to break up the material sufficiently so the CEV blade can move it out of the way. If the concrete is

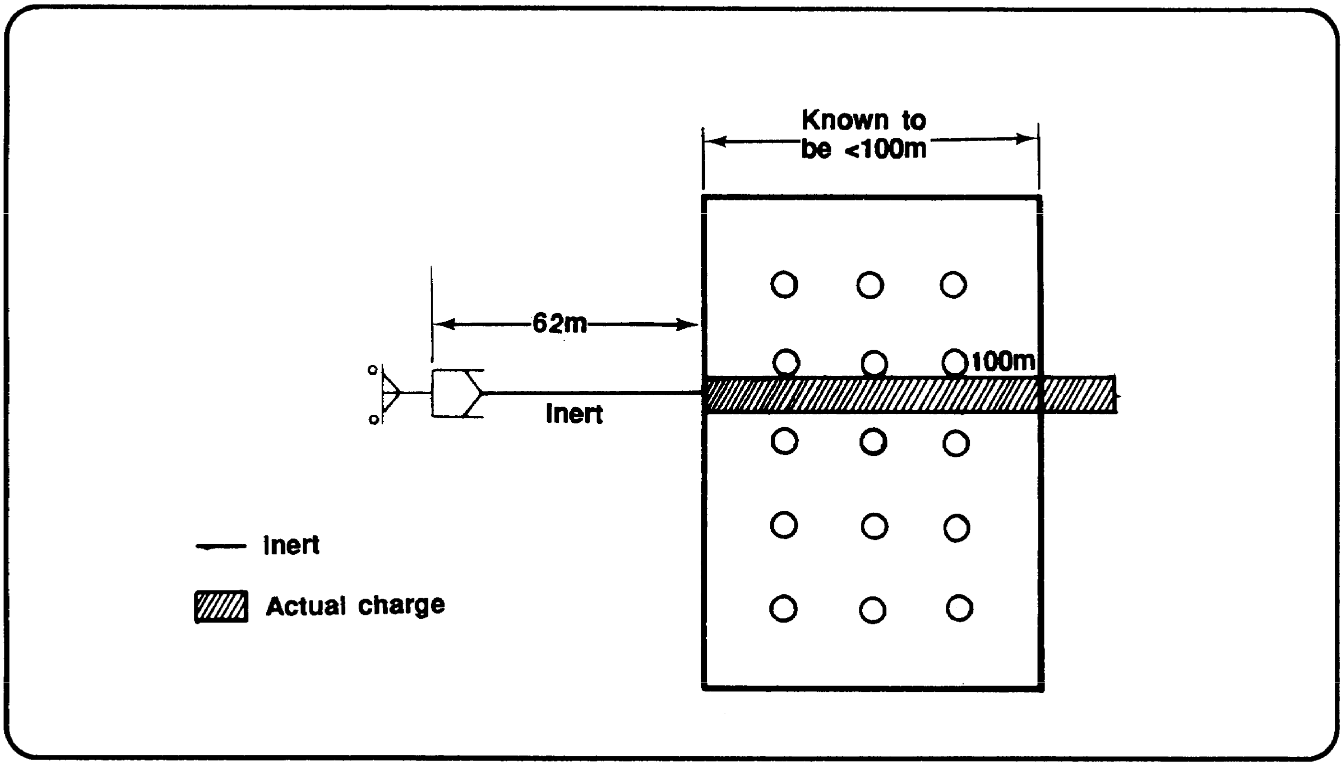


Figure C-2. MICLIC employment of a minefield less than 100 meters deep.

heavily reinforced, the steel rebar will remain. If the rebar must be removed the CEV fires additional 165-millimeter rounds at it. If this is unsuccessful, dismounted engineers use steel-cutting charges against it. If obstacles or fighting positions are constructed of rock, the HEP explosive will shatter, dislodge, and destroy it. When defensive positions are tunneled into mountains, firing above the openings will cause the rock to break and block entrances and firing ports.

The CEV attacks concrete and masonry buildings by first firing against a corner near ground level to destroy the main structural member and to strip away outer walls in order to reveal adjacent supporting structures. Then it fires against each in sequence until the building falls. The CEV can also blow entrance holes in building walls to allow assault forces to bypass obstacles and fire sacks. Firing repeatedly into the same hole can punch through several interior walls and eliminate ground floor defenders.

HEP will destroy urban roadblocks constructed of rubble or vehicles. Generally, several shots are required to break up the roadblock sufficiently so that the CEV can blade the remainder out of the way. The HEP fire will also detonate mines placed under or within the roadblock.

Even though 165-millimeter HEP ammunition is not designed for earthmoving, it is still effective because of the amount of explosive in each round. The CEV fires at the far side tank ditch wall before attempting to breach with its blade. Several rounds of HEP will cause the far side earth to

Firing at a log crib dislodges much of the interior earth and breaks the supporting log structure. The HEP round is particularly effective against bunkers and crew-served weapons positions.

The CEV 165-millimeter gun should fire at all obstacles more complex than a simple minefield or an AT ditch. The shock wave will clear AP mines and breakup the obstacle structure, making other breaching techniques easier. The CEV 165-millimeter gun is particularly effective against abatis and wire obstacles, since it breaks up the obstacle so the CEV blade can quickly remove the remainder.

The final use of the 165-millimeter gun is in the assault of a defensive position. The CEV occupies an overwatch position along with other direct-fire weapons. Normally, the engineer leaders with the assault force direct CEV fire with a predesignated color of smoke from their grenade launchers. The CEV fires on dug-in fighting vehicles and crew-served weapons positions. The HEP round will destroy any tank or armored vehicle it hits.

CAUTION

The HEP explosion creates a missile hazard within 1 kilometer from the point of detonation. Soldiers within 100 meters of the point of impact must be behind cover.

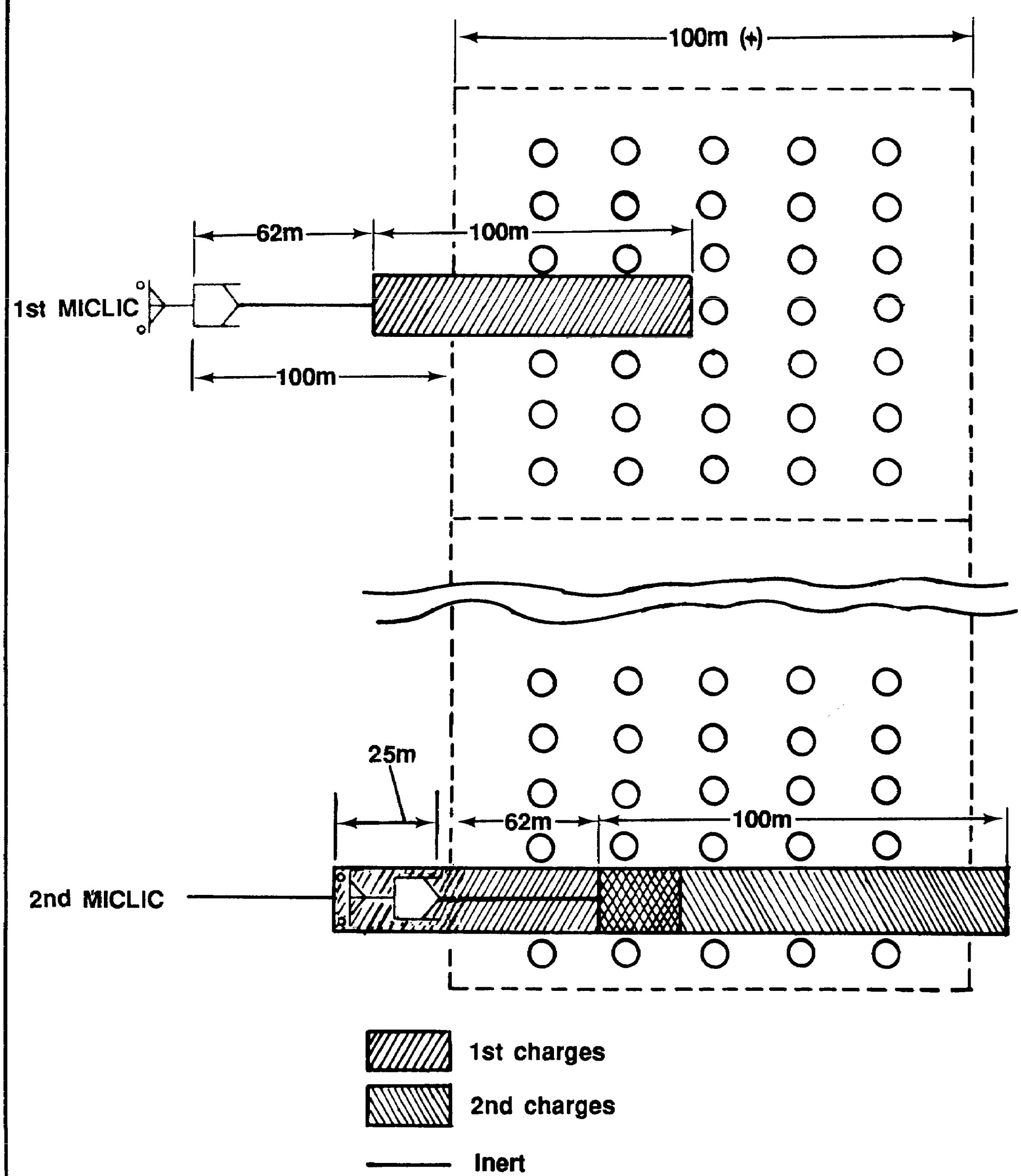


Figure C-3. MICLIC employment of a minefield of uncertain depth or greater than 100 meters.

Direct Fire

When the CEV 165-millimeter demolition gun is not available, forces can use tank and BIFV main-gun fire to reduce bunkers and urban targets. Main-gun, BIFV chain-gun, and machine-gun fires may also be used to displace or destroy surface-laid mines. The nature of tank ammunition makes it far less effective against obstacles. If available, direct fire from 155-rnillimeter artillery is almost as effective as 165-millimeter CEV fire.

Blade-Placed Antitank Wall Charges

The blade of an ACE, CEV, M88, or bulldozer can carry a large explosive charge of up to 1,000 pounds to an AT wall or other vertical-faced obstruction and drop it off against the face. The frame that carries the charge is built of lumber or small angle irons and channels. The frame consists of a rack for the explosives and a supporting structure that hooks over the dozer blade. The supporting structure has legs to hold the rack up against the wall, shoes to prevent the legs from sinking into the ground, and support arms which hold the rack and hook over the dozer blade. The surface area of the shoes and the length of the legs may be adjusted to meet local soil conditions and specific obstacle requirements. The carrier must be built to fit the specific blade to be employed. *Figure C-4, page C-6,* illustrates typical rack dimensions. *Figure C-5, page C-7,* shows the rack mounted on a CEV blade.

To breach a 6-foot-thick wall, the blade must carry an explosive charge weighing 1,000 pounds. The dimensions of the charge must be 9.5 feet long, 22 inches high, and 8 inches thick, and it must be placed about 2 feet from the ground. Leaning the charge against the wall will provide adequate contact for most vertical and sloping walls (see *Figure C-6, page C-7).*

The rack and charges are prepared in an assembly area. The blade carries the rack hooked over the top of the raised blade. The rack is emplaced by lowering the blade until the hooks are clear. The rack is then pushed against the wall. The charges, 18-pound packs of C4 or 20-pound TNT blocks, are loaded into the frame and lashed to the frame supports with rope or cord. Thin sticks are lashed to the top of the frame to indicate when the operator should drop the frame and lean the rack into the wall. These sticks should protrude 1.5 to 2 feet in front of the frame. The charge is primed with an electric priming system connected to no less than 75 meters of electric cable and a detonator in the carrying vehicle. Carrying the charge poses a significant hazard for the crew of the carrying vehicle. The vehicle should be shielded from direct fires as much as possible.

The operator of the carrying vehicle stops when the sticks at the top of the rack touch the wall. He then lowers the blade, sets the rack on the ground, and raises the rack hooks above the top of the blade. On an uneven surface, the rack may settle unevenly, making it difficult to unhook the rack. The operator backs at least 75 meters from the charge and releases the electric firing cable as he backs. The crew, buttoned in the armored vehicle, then fires the charge. This maneuver must be well-trained and well-rehearsed.

MOUNTED MECHANICAL TECHNIQUES

Like mounted explosive techniques, mechanical techniques provide the attacking commander with a quick, responsive breaching asset. These include mine plows and rollers, engineer blades, AVLBs, fascines, CEVs, and APC grapnel. Mounted mechanical techniques give the commander more flexibility than mounted explosives, since the crew can react to the type and depth of the obstacle. However, the commander must understand the limitations of his breaching equipment (for example, a mine plow can only sustain one mine detonation).

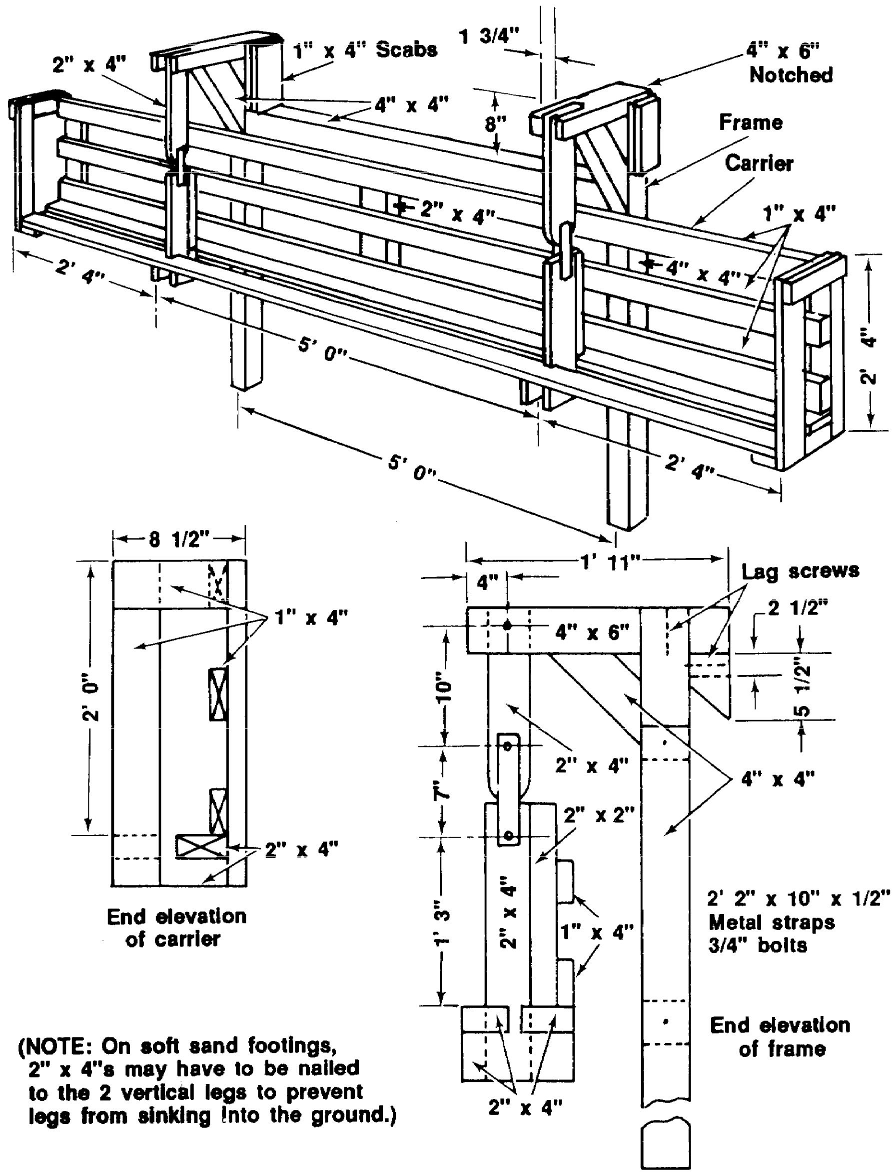
Track-Width Mine Plow and Roller

Track-width mine plows, rollers, and the CLAMS are fielded as battalion sets. They consist of three plow systems for each Ml armor company, one roller assembly per Ml company (with six roller-mounting kits provided for the armored battalion), and one CLAMS per company. Plows make lanes through minefield and rollers detect minefield and proof lanes created by other means. A roller set is not a good primary system for minefield reduction, because several mine detonations will destroy it.

Plows lift and push mines that are surface-laid or buried up to 6 inches deep to the side of the track-width lanes. The plow creates a 68-inch cleared path in front of each track (see *Figure C-7, page C-7).* The float assembly for each plow will exert enough pressure to activate most single-pulse mines. This effectively clears a section of the centerline by explosive detonation, but it may disable the plow. A “dog bone” and chain assembly between the plows will defeat tilt-rod, fused mines. Mines not lifted and moved by the plow will not be defeated. Mines armed with antihandling devices, antidisturbance devices, or seismic fuses may detonate when lifted by the plow and may disable the plow. Mines lifted by the plow are left in the spoil on each side of the furrowed path and remain a hazard until removed or neutralized.

The plow can be mounted to any Ml without special preparation or modification. Since this requires lift capability and takes up to an hour, it must be mounted well in advance of the mission. It cannot be easily mounted or transferred to another tank under battlefield conditions. The 3-ton plow will only provide a minor reduction on the tank’s maneuverability and speed; however, it will prevent the tank from climbing up a vertical step. It will affect the employment of weapons systems only when the plow is in operation.

When plowing, the Ml is restricted to a speed of less than 10 kilometers per hour (depending on soil conditions). Although the plow has an emergency disconnect, the tank



Quantity			Item
4 pieces	1" x 4"	12'	1 x 4 S4S
4 pieces	2" x 4"	10'	2 x 4 S4S
2 pieces	4" x 4"	12'	4 x 4 S4S
1 piece	4" x 6"	4'	4 x 6 S4S
8 each	1/2"	7'	Lag screws
4 each	3/4"	3"	Bolts
2 each	3/4"	6"	Bolts
4 each	1/8" x 2"	10"	Metal straps
			Assorted nails

Figure C-4. Blade charge rack dimensions and materials list.

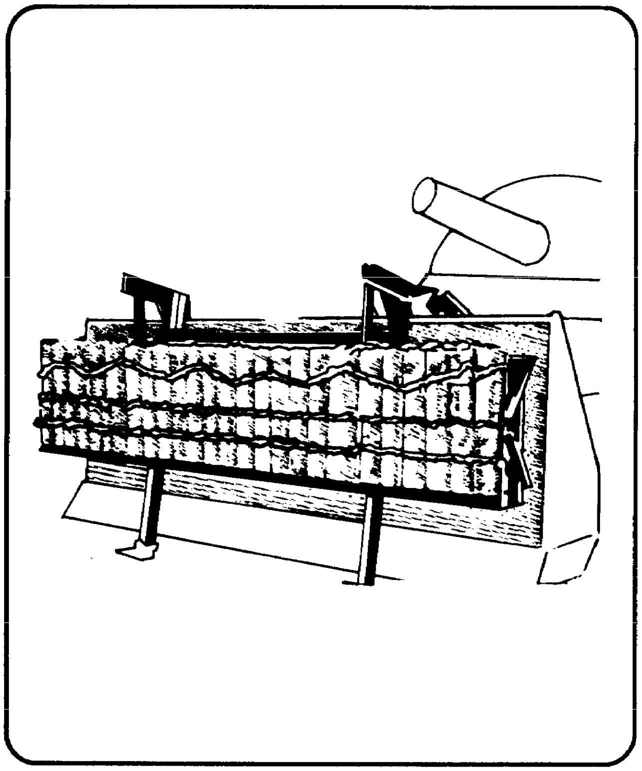


Figure C-5. Charge rack loaded on a CEV blade.

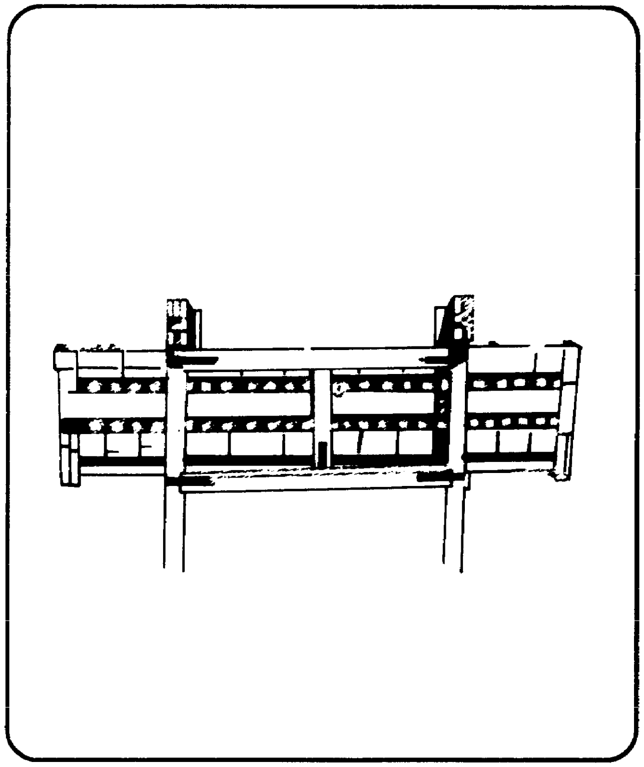


Figure C-6. Charge placed against a wall.

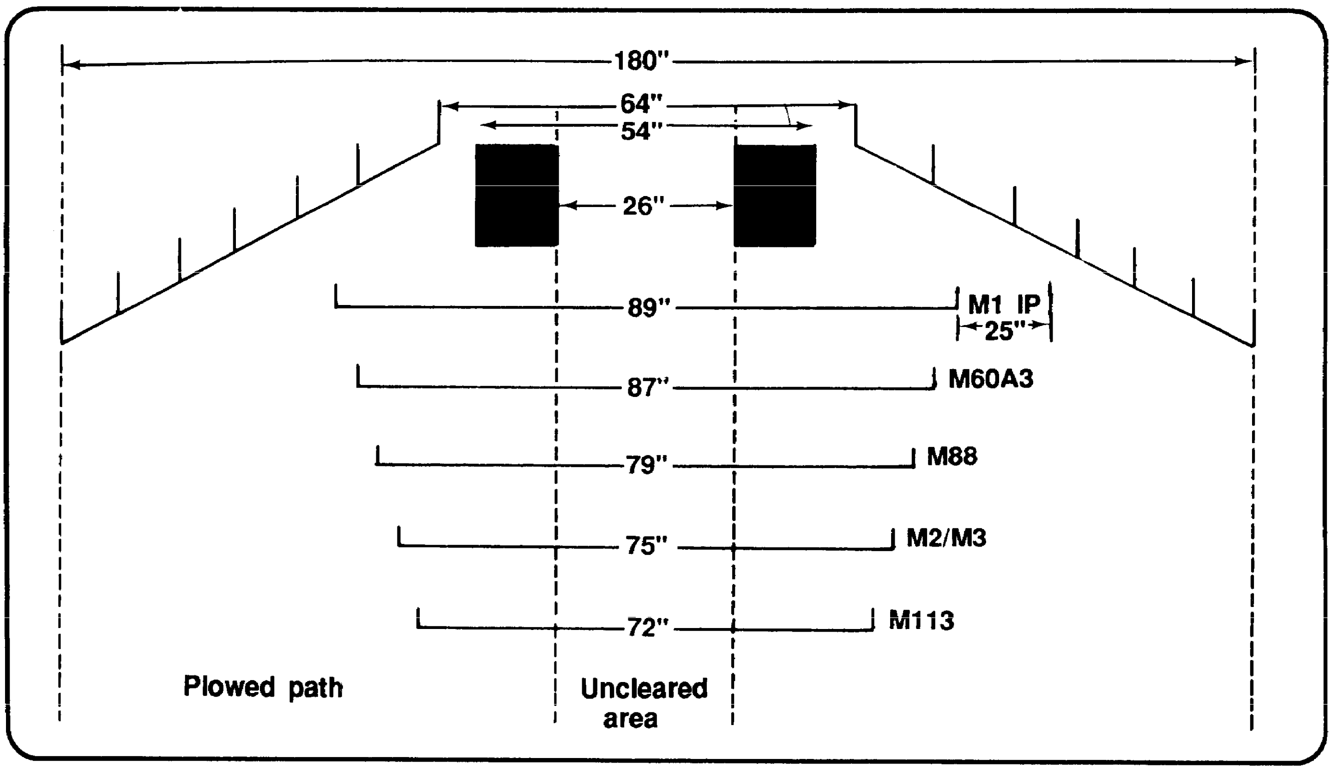


Figure C-7. Mine plow width compared to track vehicle widths.

cannot maneuver when it is plowing and must continue on a straight course through the minefield to prevent damage to the plow. When the tank is plowing, the main gun must be traversed to the side, since a mine detonating under the plow may throw it violently into the air and damage the gun tube. The area selected for the lane must be relatively flat and free of rocks or other obstructions.

The operator should begin plowing about 100 meters from the estimated leading edge of the minefield and 100 meters beyond the estimated far edge. This ensures that the lane extends through the entire minefield. A second plow should not replow the lane, since any deviation from the first plowed path will push nontilt-rod mines horn the lane centerline into the track-width lane created by the first plow.

Rollers are designed to detect minefields. The roller sweeps a 44-inch path in front of each track (see *Figure C-8)*. A "dog bone" and chain assembly between the rollers defeats tilt-rod fused mines. Magnetically fused mines will not be defeated unless activated or crushed by the roller. The roller is designed to withstand about two explosions without damage; however, this depends on the amount of explosive material in the mine. Large blasts may destroy the roller and vehicle or injure the crew.

The roller can only be mounted on Ml tanks modified with the permanent attachment of the mine-roller mounting kit. Each armored battalion will have six modified tanks. As with the plow, attachment of the roller to the tank is a cumbersome, time-consuming operation and difficult under battlefield conditions. It requires a lift capability to mount. The roller weighs more than 10 tons and has a great impact on the tank's maneuverability and speed (limiting it to 5 to 15 kilometers per hour. The mounting kit itself has a minimal effect on the vehicle's operational capabilities.

Normally, the roller is carried by a tractor trailer. It may move with the combat trains or farther forward if the roller is needed. Planning for its movement and designating an assault position for mounting the roller on the tank is critical if it is to be employed effectively.

When it is employed, the roller tank must travel in a relatively straight path, since tight turns may cause the rollers to deviate from the path of the tracks and miss mines. Ground fluctuations, bumps, and berms may cause the rollers to lift from the ground and miss mines. The roller-equipped tank cannot negotiate gaps on its own. It cannot cross the AVLB, because it exceeds the weight capacity of the bridge and will severely damage curbs and paneling. The main gun must be traversed to the rear or side for a mine encounter, since a mine blast will throw the roller or parts of the roller violently into the air and may damage the tube.

The mine roller is a minefield detection system. It is most effectively deployed to lead columns on route movement but can be used to precede tactical formations. In column movement, unit vehicles travel a narrow path and one or two mine rollers can effectively detect any mines in that path by

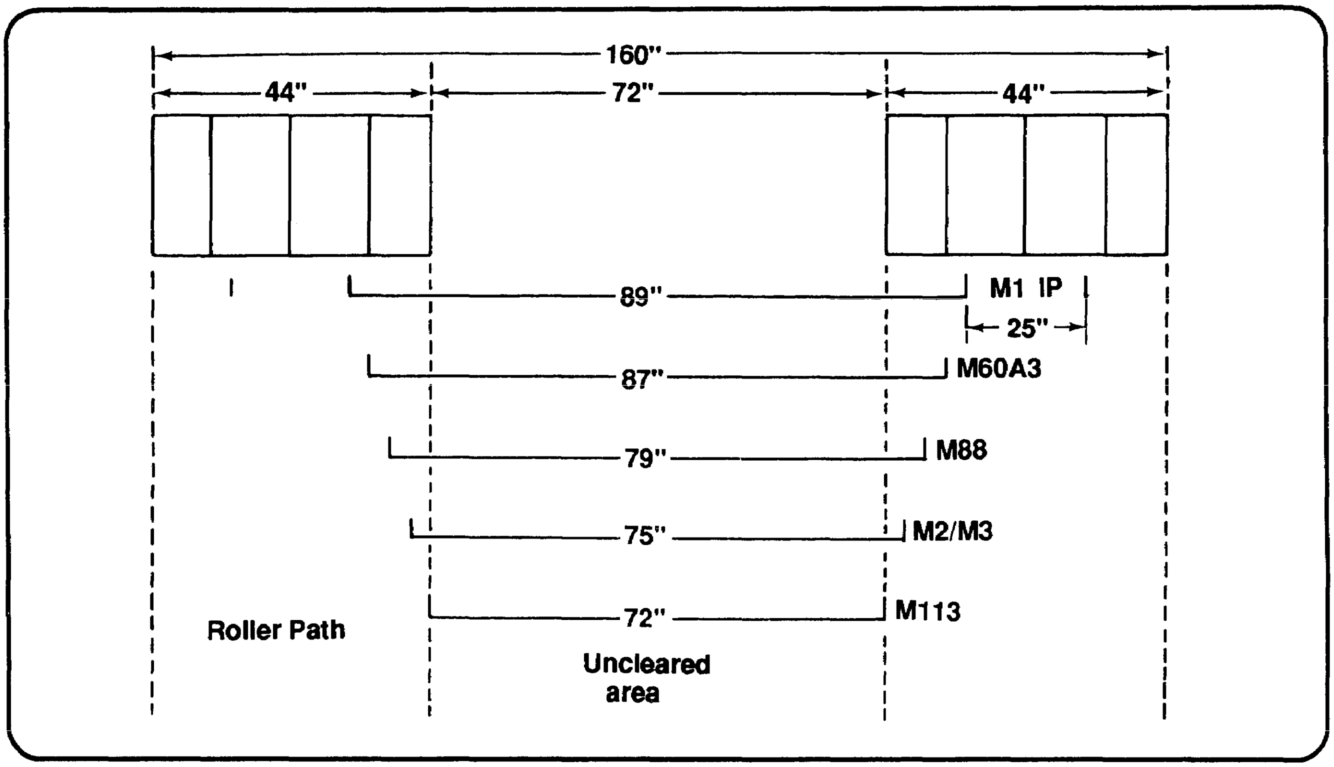


Figure C-8. Mine roller width compared to track vehicle widths.

leading the column. However, this causes the column to slow to 5 to 15 kilometers per hour.

Mine rollers can also be used to detect minefield in front of deployed tactical formations, although more than one roller tank is required for good probability of detection. A company deployed across a 500-meter front led by one roller tank, has less than a 40-percent probability of detecting a standard Soviet minefield with the roller. Two roller tanks increase this probability to approximately 80 percent, and three virtually guarantee detection. The attacking TF must mass roller tanks on the key axis if it is to employ them as minefield detectors. The mine rollers move several hundred meters in front of the unit's main body under continuous overmatching fires from bounding company teams. If a roller tank detects a mine or is fired upon, the roller tanks immediately launch smoke grenades and seek cover. If cover is not available, they breach with their rollers, ejecting markers from their CLAMS. Overwatching company teams must begin immediate suppression of all observed and suspected positions.

Minefield detection with rollers slows units considerably. There are two instances when the loss in maneuverability can be worthwhile. They are when the threat template indicates the presence of minefield but the exact location is unknown; or when an enemy strong point is detected and the tactical obstacles shaping the file sack have not been found.

Mine rollers can be used to breach or proof lanes through harassment mines and low-density minefield along roads or trails. This role is similar to route-clearing operations conducted in Vietnam.

Rollers may be employed in deliberate breaching operations to detect predicted but undiscovered minefield. Standard Threat mine spacing does not provide a 100-percent probability of mine encounter by one roller system, so rollers must be employed in pairs. Generally, the two roller tanks will be spaced about 100 meters apart and covered by overmatching units using bounding movement. Sufficient overmatching direct fire should be employed to effectively suppress enemy fires. When a roller tank encounters a mine, it continues until it reaches a covered hiding position. The force then employs deliberate breaching techniques to force the obstacle. Roller tanks employed in this manner normally act during the firing of an artillery preparation on the defending positions.

Rollers can be used to proof lanes in obstacles breached by other means such as MICLICs or mine plows. A roller pulling a trailer-mounted MICLIC can be deployed to proof the lane created by a MICLIC from another vehicle. The roller then fires the second MICLIC and proofs its own lane.

A second roller can overlap to cover most of the dead space unrolled by the first tank. This technique is not to be used when proofing lanes created by plows, since the overlapping roller will encounter all of the mines in the spoil next to the plow-furrowed track lane. Overlapped rolling also makes lane negotiation easier for vehicles such as M113s, which have little margin for error when following the proofed lanes of a single roller.

If rollers are designed to participate in a deliberate breach operation, or if the force chooses to incorporate rollers into in-stride breach plans, they must be mounted before mission rehearsals. If rollers are left unmounted, they are carried in the TF formation on M916 tractor trailers. The rollers will require lift capability (such as an M88), **a secure** location, and 30 to 60 minutes to mount on a tank fitted with the mounting kit.

The plows and roller systems can be stopped by gaps in or in front of the minefield. A MICLIC fired over a gap can break down berms and embankments of the gap. However, plows and rollers must wait until a blade (such as the ACE or CEV) fills the gap before they can pass. The plow tank can cross a gap on an AVLB, but roller tanks will exceed the bridge capacity and severely damage bridge panels and curbing.

Engineer Blades (M9 ACE, CEV, Dozer)

Blades are ideally suited to break down and reduce earthen gaps such as AT ditches and road craters. Normally, the primary blade vehicle for a breach is the CEV. The ACE and the bulldozer are used in the deliberate breach after indirect fires have been eliminated; however, either of them can be used wherever they are needed.

The blade fills a gap or tank ditch by starting its push from far back. It takes shallow cuts, pushing the earth forward into the gap until the hole is sufficiently filled to make a passage. The blade improves the breach by pushing material back from the far side. Firing the CEV 165-millimeter demolition gun into the far side of a gap can dislodge earth and speed the reduction. If the blade must make a passage through urban rubble, it is sometimes faster to push an earthen ramp over the rubble than to remove it.

The blade is effective against wire. It is important to remove the pickets supporting the wire with the blade, then breaking the wire is simple. Before blading through a wire obstacle, the engineers should check for mines. If this is not possible, the blade should be set to skim to remove wire and mines.

Abatis and log cribs are special problems for blades. They are designed to be very difficult to push out of the way. Normally, explosives are used on the forward face of a log crib before the blade pushes the rubble aside. This demolition effort can be accomplished with satchel or cratering charges or with the CEV 165-millimeter demolition gun. The same is true of an abatis. Before the blade can be effective, abatis must be loosened up with explosives, winches, or cables, or by dismounted engineers using chain saws.

The engineer blades on the M9 ACE, CEV, and bulldozers were not designed for breaching minefields. They can be employed as a last resort but this is extremely dangerous to the equipment and its crew. The blades are used to skim when removing surface and shallowly buried mines. It is easy for mines to roll under the blade during this process, particularly if the surface is irregular. Mines also float in the spoil in front of the blade, and as the spoil rolls it may detonate the mines. The operator should use a curved path or herringbone skimming technique. He makes multiple overlapping passes, stripping away about 6 inches of soil each time (see *Figure C-9)*. The operator should skim for no more than 15 meters at a time. This prevents excessive spoil from building up in front of the blade.

The bulldozer exposes the operator to AP mines. If used, the operator's cabin should be sandbagged or reinforced with a steel plate, and the lane should be cleared of trip wires with grappling hooks.

Armored Vehicle-Launched Bridge

The AVLB is an engineer asset with quick bridging capability (up to 18 meters) for military load class (MLC) 60. For MLC 70, it can span 15 meters. The AVLB is not the first choice for breaching a gap during the in-stride breach, because it is slow and generally moves a terrain feature to the rear to avoid attracting fires. During the launch, the AVLB presents a high profile and can extend above screening smoke to reveal the breaching location. The bridge can be recovered from the far bank and employed again. The AVLB can be used to overlay an understrength bridge, but it must be cribbed to avoid placing any load on the bridge. It can also be placed on a stream bottom to provide a fording capability over soft or rocky material, but this can cause severe damage to the bridge. The mine roller cannot cross the AVLB without doing extensive damage to the curbing. It takes about 5 minutes to deploy the AVLB.

Fascines

Fascines are large cylindrical bundles of material (usually wood poles, plastic pipes, or metal pipes) loosely bound together and placed singly or in groups in gaps to create a lane. The material must have enough width and load-bearing capacity to handle the crossing traffic. British engineer armored vehicles often mount fascines to any armored vehicle using cable, rope, or mounting kits. Fascine bundles can be carried on the rear deck of the CEV. The CEV boom remains in its stowed position, with the fascine bundle over the rear deck. To employ the fascines, the CEV pulls up parallel to the gap, swings the fascines over the side by rotating the turret, and releases the cable holding them. Fascines can be carried on pole trailers and low-bed trailers to an attack position, where they are loaded onto the CEV.

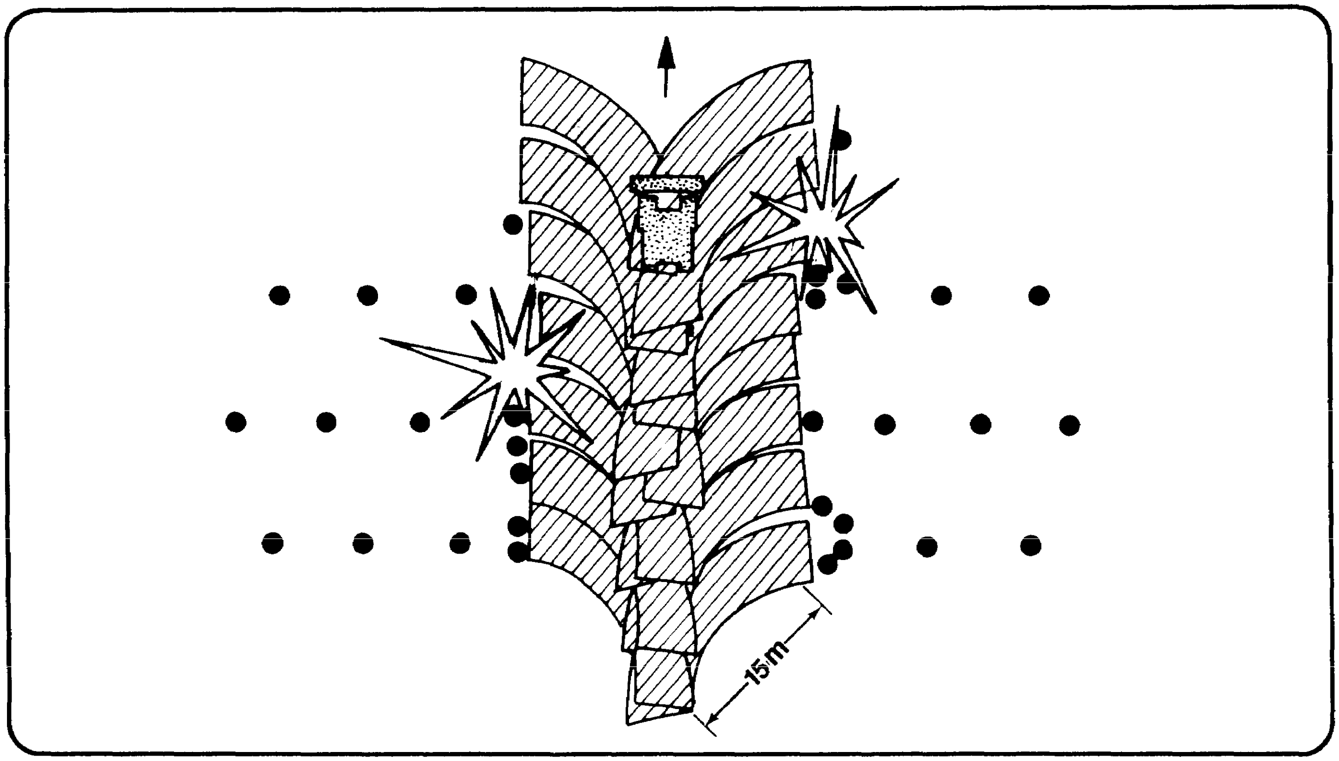


Figure C-9. Engineer blade skim pattern.

CEV Boom and Winch

The boom on the CEV deploys a winch cable like a small crane. It rotates with the turret and is used as a lifting device in breaching operations. If a CEV is not available, the boom on the M88 can be used. It is designed to lift materials but does not rotate. The M88 boom can remove disabled vehicles and rubble that cannot be bladed out of the way. It is a critical device whenever the obstacle must be reduced by either pulling or lifting. The CEV carries wire rope and four-part slings with hooks in its bustle rack to allow rapid rigging of material to be moved. It also carries a logging chain, which can be used to assist with lifting or pulling material out of the way.

The CEV boom is particularly useful for reducing an abatis. When the abatis is constructed, the trees are dropped facing the attacker and are overlapped so that pushing them with the blade simply makes them interlock more and makes the obstacle more difficult. The abatis must be pulled apart toward the attacker. The CEV uses its cable and boom to pull the trees out of the way. The cable can be attached to log carriers or log chains to speed connection to trees. A second technique is for dismounted engineers to carry the cable deep into the abatis and saw off a large section of a tree trunk with chain saws. The cable is then connected to the section and the CEV pulls the log, spreading the abatis trees to the side. The abatis can also be dismantled by cutting trees from their stumps and lifting each out of the way with the boom while working through the obstacle.

The CEV boom can also be used to breach wire obstacles. A large grapnel is constructed out of angle iron or bar stock and is connected to the winch cable. The grapnel is pitched into the wire by rotating the turret while releasing the winch. The wire is lifted as high as possible and the CEV backs up to pull it out of place.

The CEV boom can carry an H-frame made from M4T6 bridging or from any other available material which can span a gap or be dropped over wire. If mines are suspected under the wire, dropping the H-frame will either detonate them or allow safe passage by dismounted assault forces or engineers. The H-frame will allow rapid passage of a gap by dismounted assault forces and can quickly be converted into abridge by engineers.

The CEV boom can carry fascines, but these are normally carried on the rear deck and swung to the side with the boom stowed. It can also carry a suspended charge that is dropped into the gap to destroy the near side so the CEV blade can complete the breach. It is critical for reloading MICLIC launchers.

Armored Personnel Carrier (APC) Grapnel

If wire obstacles contain AT mines, it is preferable to drag the wire out of the way rather than run a blade through it. A simple grapnel can be fabricated out of welded angle iron or bar stock and fastened to a length of wire rope (preferably ½ inch) as a grapnel. This wire rope is fastened to a lifting eye on the top of an APC or some other strong fastener on any armored vehicle. The vehicle is driven to the wire and the crew throws or places the hook into the wire next to a picket. The vehicle then backs away, stretching and breaking the wire. After the wire is pulled out, the breach must be checked for buried mines. The grappling crew must be buttoned up during the drill in case they detonate a bounding AP mine. Every engineer APC carries one of these grapnels.

DISMOUNTED TECHNIQUES

Manual reduction techniques provide a backup to mechanical systems. Manual obstacle reduction is also the only method capable of solving any breaching problem regardless of situations and conditions. However, this method requires more breaching element time and breach force protection. Some types of terrain, weather, and sophisticated fuses can severely degrade the effectiveness of rollers, plows, and line charges. A clever opponent can capitalize on equipment limitations by designing an obstacle to defeat our standard breaching devices. Dismounted soldiers are capable of analyzing and solving a variety of problems in a far more flexible manner than with mounted equipment. Engineers reducing obstacles manually use hand-tools, hand-emplaced explosives, grapnel hooks, ropes, ladders, timbers, probes, mine detectors, and a variety of expedient materials.

The manual techniques, often called "manual breach battle drills" by the engineers who use them, must be extremely well practiced. Soldiers in the demolitions team are assigned special tasks such as lane marking, firing system construction, or demolitions placement. Each task is thoroughly rehearsed for the assigned soldier. All engineers in the team are cross trained on all tasks involved in the breach. Demolitions are prepared well before arrival at the breaching site. The platoon must rehearse the reduction technique until execution is flawless. During the breach, the engineer platoon will be exposed in the lane for 5 to 30 minutes or more, depending on the mission and the engineers' level of training.

Manual Reduction of Surface-Laid Minefields

The Soviets possess a significant mechanical mine-burying capability. They also hand-bury mines; however, they often surface-lay them for speed and to facilitate later recovery. A surface minefield does not normally include AP mines, so trip wires are not a problem. Buried mines will usually be found in a prepared defense requiring a deliberate breaching operation. When the reduction team does find buried mines, they should assume that antihandling devices and trip wires are present until they prove otherwise.

When the obstacle consists of surface-laid mines, a manual reduction technique is probably the most effective. Generally, there are no AP mines and covering fires are predominately AT fires. Using 3- to 5-second rushes, the demolition team moves quickly through the minefield. The team takes advantage of folds in the ground for cover, placing blocks of explosives on mines within the lane. They also emplace lane markers as they traverse the minefield. The final member of the demolitions team completes a line mail attached to all explosive blocks and detonates the system. After the mines are blown, the team makes a visual check to make sure all mines are cleared before directing traffic through the lane. This technique should reduce a standard 120-meter-deep minefield in 5 minutes from the time the demolition team breaks cover and begins.

In a variation of this technique, blocks of explosives are preprinted with a 2-minute fuse. The team moves through the obstacle, lights the fuse on a single block of explosive, and sets it on a surface-laid mine. The team continues to move to the next mine and repeats the same process. This technique is faster than the line-main method. An engineer squad can make two lanes through a standard 120-meter-deep minefield in less than 3 minutes. This method has certain risks; for instance, there is a higher chance of misfire with individually primed demolitions. Possible injuries in the minefield containing initiated firing devices can defeat the closely timed breach, and detonations occurring at different times can dislodge charges next to other mines. Use this technique only when speed and the mission necessitate such risks.

Manual Reduction of Buried Minefield

Manually reducing a buried minefield is extremely difficult. If mine burrows are not easily seen, mine detectors and probes must be used to locate the mines. The mines are then destroyed by hand-emplaced charges using the same techniques as those used with surface-laid mines.

Grappling Hook (Grapnel)

The grappling hook is a multipurpose tool that can be used in manual obstacle reduction. Soldiers use this device to detonate mines from a standoff position by activating trip wires and antihandling devices. After the grappling hook is used to clear the trip wires in a lane, dismounted engineers can move through the minefield and visually locate and prepare surface-laid mines for demolition. In buried minefield, soldiers first grapple and then enter the minefield with mine detectors and probes. This is a very slow procedure and is only suitable for the deliberate breach after fires have been eliminated.

A length of light rope 60 meters or longer is attached to the grapnel for hand-throwing. The range for throwing the hook attached to a cord is usually no more than 25 meters. The excess rope is for standoff distance when the thrower begins grappling. The soldier tosses the hook-and-seek cover in case the impact of the grapnel and rope detonates a mine. The thrower then moves rearward, reaches the end of the excess rope, takes cover, and carefully pulls the hook toward him. After recovering the grapnel, the thrower moves forward to the original position, tosses the hook, and repeats the technique at least two more times. Then he moves to the end of the grappled area and repeats this sequence to the depth of the minefield. Multiple grapplers can clear a lane of trip wires more quickly and thoroughly, but their efforts must be simultaneous. The team must be conscious of the kill radius of the mines they are reducing. Some Soviet AP and AT mines are lethal to personnel in the open for up to 50 meters.

CAUTION

The soldier cannot physically throw the grapnel beyond the casualty radius of bounding AP mines.

A hit on a trip wire may destroy *or* scatter the hook and cord. Engineers using this technique must carry extra hooks and cord.

A slower but safer method of handling trip wires is to conduct a deliberate visual search for them. The soldier low crawls through the minefield parallel with the ground. This gives him the best chance of deleting trip wires. He employs a powerful flashlight, if available, to cause reflections and shadows. He can also sweep a wand with a dangling thread over the ground ahead of him and watch for the thread to be disturbed by a trip wire. When a trip wire is discovered, it is carefully followed to the mine, then destroyed with a demolition charge.

Deliberate Breach with Mine Detectors

Mine detectors are used along with probes in a deliberate breach after fire has been eliminated from the obstacle. The breaching party requires four mine detectors to sweep a single (8-meter) lane. This requires two engineer squad sapper teams, since one team is only capable of operating two detector teams simultaneously.

A detector team consists of three soldiers. The detector operator sweeps a 2-meter path, carefully observing the ground for visual indicators as he moves. Immediately behind him, his assistant also visually searches the ground for mine indicators. When the detector operator locates a suspected mine, his assistant places a breaching charge on it. The third member of the team follows with additional breaching charges and a roll of detonating cord. He lays a line main through the minefield and clips the detonating cord from each charge to the line main. The detector team carries 16 breaching charges and can expect to encounter up to three mines in a standard minefield. The detector operator sweeps at a speed of about 10 meters per minute.

The detector teams sweep in echelon, spaced about 25 meters apart to prevent interference between detectors. Each team is careful to overlap the lane swept by the team to its front. The breach should continue for a distance of at least 150 meters past the first suspected mine location. When each detector team has passed the suspected minefield, the four line mains are connected together and the charges are detonated. The lane centerline is marked for passage.

M1A1 and M1A2 Bangalore Torpedoes

The bangalore torpedo is a hand-emplaced, explosive-filled pipe that is effective against wire obstacles and has limited effectiveness against AP mines and some AT mines. Each section of pipe is 1.5 meters long with 10 sections (a total of 15 meters) per kit.

Wire Breaching Procedures

The squad moves to the reduction site with squad members carrying bangalore torpedo sections. Wire obstacles seldom are deep enough to require the full bangalore kit. The squad can form two breach teams and breach the wire in two positions simultaneously (normally about 25 meters apart for a dismounted attack) or two obstacles in depth. Each breach team has three members and can carry five bangalore sections plus the accessories necessary to breach up to 25 feet of wire obstacles. The breach team assembles bangalore sections and pushes them under the wire, primes the torpedo with a single cap in the detonator well, and detonates the charge. Normally, the bangalore torpedo is primed nonelectrically, since electrical firing systems are too complex and time consuming to use in an assault breach. Because the bangalore torpedo throws lethal fragments of wire for long distances, the breach team must ensure that all personnel within range have sought cover before the detonation.

Mine Breaching Procedures

The bangalore torpedo kit will clear a l-meter-wide lane. Several threat and friendly mines require two impulses or a single, long impulse for detonation. The bangalore generates one short impulse. Bangalore torpedoes generally do not generate enough overpressure to detonate AT mines unless they are immediately beside or on top of them. As a last resort against AT mines, the bangalore may be placed immediately adjacent to surface-laid mines. If the mines are mechanically buried in furrows, a sapper team lays three sections along the furrow perpendicular to the direction of the lane (see *Figure C-10, page C-14).* If the mines are staggered or widely spaced, the team lays sections parallel to the direction of the lane.

Manual Antitank Ditch Breach

The dismounted sapper team from an engineer squad can quickly breach an AT ditch using hand tools and demolitions. This may be a preferred technique if the enemy has effective AT fires covering the ditch.

The team uses satchel charges preconnected to detonating cord branch lines. They dismount as close to the ditch as possible and move to the ditch using dismounted movement techniques. On arrival, the team quickly digs four holes in the side walls (two in each side) near the ditch bottom for the satchel charges. The holes should be approximately 5 feet apart in each wall and directly opposite each other. After the holes are approximately 2 feet deep, the satchel charges are placed, connected to a prefabricated ring main, and tamped with loose earth. The squad leaves the ditch, takes cover, and detonates the charges. Then they quickly cut down the remaining loose soil to allow vehicles to pass, The entire operation is conducted in 10 minutes or less.

Assault Ladders and Footpaths

Assaulting well-prepared fortifications will require the force to attack in columns of platoons through wire and mine obstacles, reinforcing trenches, and steep walls. An example of a difficult fortification to assault with dismounted troops is the desert strongpoint. This type of strongpoint uses a 3- to 5-meter-high circular berm on the desert floor. This protects the defender while he prepares necessary weapons and vehicle fighting positions. The attacking force must fight through the tactical and protective obstacles outside the berm and climb the wall to assault the weapons pits. Folding assault ladders constructed from metal or wood can be carried on armored vehicles or by soldiers. *Figure C-11, page C-14*, shows an example of a steel folding ladder. The assault ladder is required for passing dismounted soldiers through AT ditches, over AT walls, and into fortified buildings. It can also be used to layover wire obstacles. Every engineer APC should carry an assault ladder strapped to its side.

In some cases, vehicles cannot be used to pull wire entanglements off assault paths for fear of detonating AP mines in the process. To make an assault path, soldiers may prepare material to be placed over the wire. The assaulting troops must clear the wire of AP mines before laying this material on the wire. *Figure C-12, page C-14*, shows a footpath made by using boards attached to a roll of chicken wire. Many variations are possible, based on available materials.

Covert Breaching

Many of the techniques already described are useful for covert breaching. Even explosive techniques are useful if the charges are installed but not detonated until the attack begins. However, the typical covert breach is designed to allow silent passage of a dismounted assault force and must produce a lane without alerting the enemy.

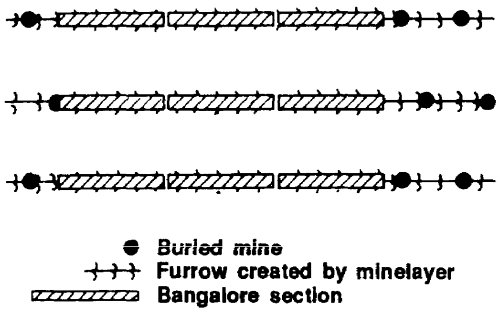


Figure C-10. Placing bangalore sections to breach a mechanically emplaced minefield.

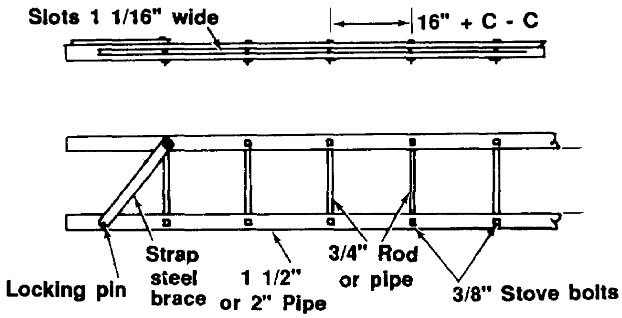


Figure C-11. Folding assault ladder.

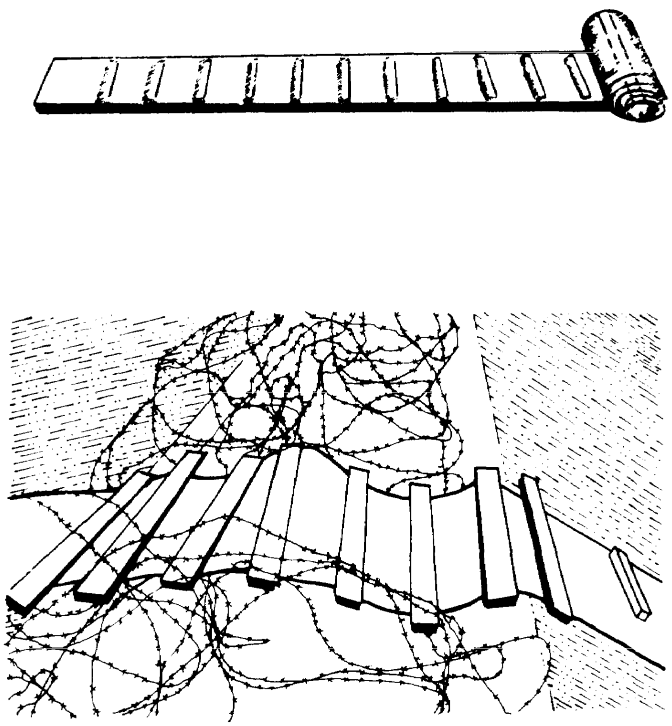


Figure C-12. Barbed wire ramp.

A sapper squad leader designates a team to conduct a covert breach of a minefield. The three-member team consists of two probers and a lane marker and cutter (see *Figure C-13*). The team removes all equipment except for flak vests and weapons and rolls up their sleeves. Only nonmetallic probes are used. Mine detectors, grapnel hooks, and explosive charges are prepared for contingency use. The team uses stealth and available cover and concealment during movement to the breaching site. The two probers position themselves next to each other. The lead prober clears a path 1 meter wide; the second prober follows one body length behind, overlapping the first path by 0.5 meters. They trace trip wires to their origin, cutting slack wires and marking taut ones. Once a mine is discovered, it is marked. All mines and taut trip wires are bypassed by at least 2 meters. The breach lane turns as mines and taut wires are encountered and marked. Initially, the breach centerline is marked. The lane is improved by marking both sides, if time permits. The probers mark with chemical lights, tape, or field-expedient markers. If a chemical light is used, it must be a different color than the ones used for marking mines. The lights must also be shielded from enemy observation. Extensive trip wires and mines may justify the need to use explosive manual breaching to open the lane and serve as the signal for suppression, obscuration, and assault.

A sapper squad prepares a three-member breach team for the covert breach of wire. The team uses stealth and available cover and concealment during movement to the breaching site. The team consists of a cutter and two holders and probers. The team probes up to and conducts an inspection of the wire obstacle, looking and feeling for pressure prongs and trip wires. After an area of the wire has been cleared of booby traps, the two holders hold the wire. To reduce noise, one soldier wraps cloth around the wire where it will be cut. The soldier with the wire cutters then cuts part way through the wire held between the other two soldiers' hands. The wire is then bent back and forth until it breaks. This continues until the wire portion of the obstacle is cut through. Then the team stakes down or ties the wire to prevent it from springing back and closing the breach.

Lane Marking

Initially, all lanes are marked with centerline, entrance, and exit markers. These are installed during and after obstacle reduction to ease passage of the assault force. As required, markings are improved for follow-on forces and are eventually replaced with permanent fencing.

The CLAMS allows rapid, remote marking of the breached lane that can be seen at night. It can be mounted on the rear of any M1 tank without major modifications. It is only adequate for the initial assault and must be replaced and improved as soon as possible with a two-sided marking using a HEMMS or according to the unit SOP.

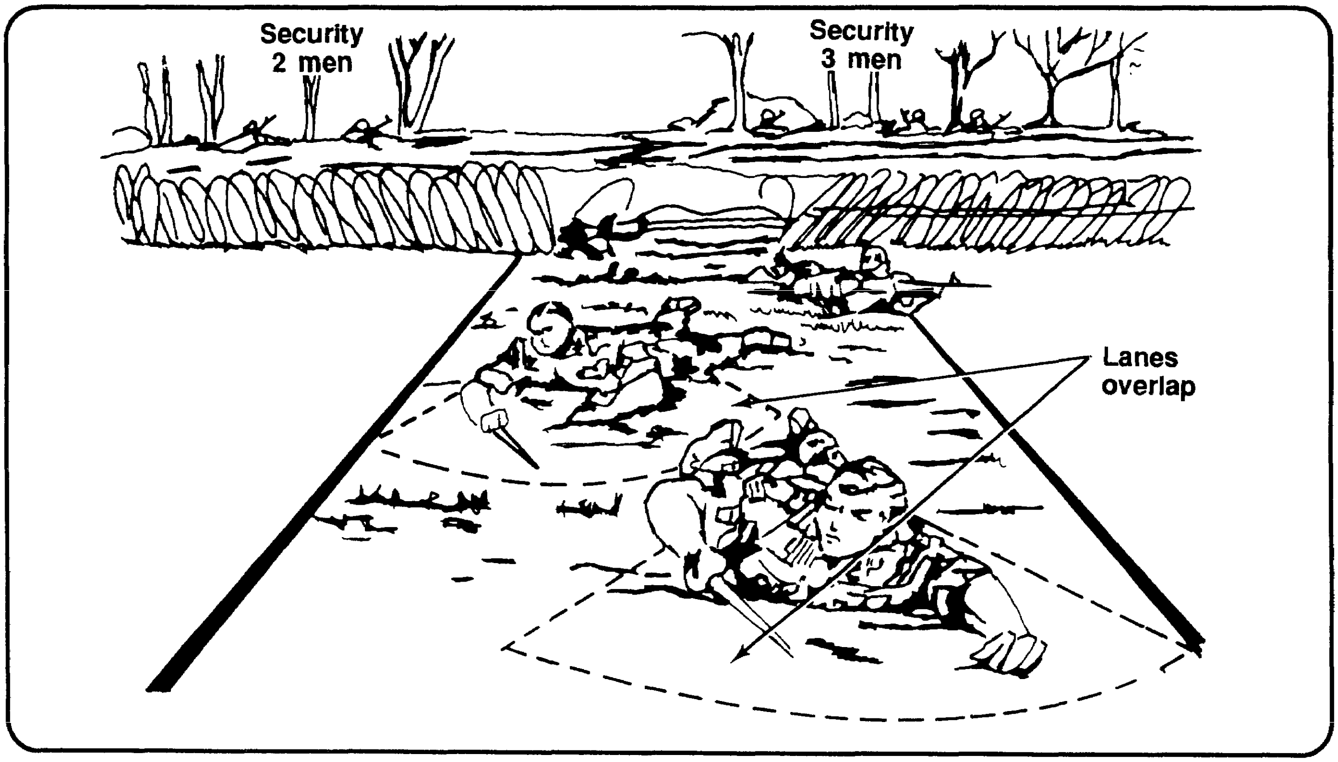


Figure C-13. Probers clearing a path.

A critical requirement for the initial marking of assault lanes is to provide marking that buttoned-up vehicle crews can see easily through smoke. Tanks and BIFVs have infrared sights that can see heat sources through smoke. Centerline marking can use infrared chemical lights, railroad flares, or simple smudge pots made from cans filled with earth and diesel fuel.

A simple system for centerline marking uses HEMMS poles cut to 18-inch length and wrapped with fluorescent flagging. Chemical lights can be inserted into the ends of the poles if they are needed. Both ends of the flagging are left free to blow in the wind and aid visibility. A soidier can carry a spare M60 machine-gun-barrel bag full of stakes and install them as he unrolls detonation cords or places charges (see *Figure C-14).* Other techniques are to unroll flagging or engineer tape along the centerline. Tent pegs are inserted through the tape at intends to pin it to the ground. If necessary, chemical lights are taped into the Vat the top of the tent peg.

Bicycle flags on 6-foot nylon poles are useful for marking the sides of a lane. They can also be fastened to a cross brace on the center of an AVLB so that tank drivers can center their vehicles and cross faster.

Highway marker cones are useful for marking a V-shaped entrance to a lane and can be used to mark the centerline if it is shorter than 18 inches. If large cones are available, they should mark each side of the lane in pairs.

U-shaped pickets can be used to mark the sides of the lane instead of centerline markings. The pickets should be installed close together (no more than 5 meters apart) and have flagging looped between them to provide a visual “wall” at the edge of the lane. Chemical lights are taped to the pickets for night operations.

Wire is installed to mark each side of the lane after the assault force has passed through the obstacle. It can either be a standard cattle fence or simply one set of concertina staked to the ground. Standard minefield-marking signs are hung on the fence.

Plywood panels are used to make high-visibility entrances to lanes. They are deployed in a huge V shape (like a fish trap) so that a fo1low-on unit can quickly orient on the lane and pass through with minimal delay. Generally, the panels are half or full sheets of plywood with large arrows painted on one side and the reverse side painted with camouflage paint. The first set is installed 500 meters ahead of the obstacle and spread about 500 meters apart with the arrows pointed to the center. The second set is installed about 250 meters ahead of the obstacle and spread about 250 meters apart with the arrows also pointed to the center. The final set is at the entrance of the lane and is installed at both sides of the lane. Plywood panels are prepared before the attack and can be carried in the bowl of the M9 ACE. They are normally installed after the assault force has attacked the defender but before the obstacle is turned over to follow-on forces.

Example of Multiple Reduction Techniques

A breach force may be task organized with multiple reduction assets to be employed simultaneously. For instance, the breach force may consist of a tank platoon with three plows and a roller as well as an engineer and infantry platoon, each towing a MICLIC.

The MICLIC charges are reserved for the most dangerous minefield. If the first minefield encountered is a surface minefield, the plow tanks engage the plows and move through the minefield, marking the centerline of each lane with the CLAMS. In this case, the breach force will attempt to create two plowed lanes, keeping the remaining plow tank in reserve for close-in overwatch and suppression. The infantry and engineers assist with suppression from their vehicles and provide close-in security with dismounted squads.

If the obstacle is a buried minefield, the engineer squad carrier deploys into the obstacle and fires the MICLIC. The dismounted squad marks the entrance to the lane and is prepared to employ dismounted breaching techniques if the mechanical breach fails. The plow tank towing the second MICLIC launcher immediately enters the lane breached by the frost MICLIC, moves two vehicle lengths into the lane, and fires its MICLIC. It passes through the minefield, marking the centerline with its CLAMS, and moves out of the way of follow-on forces into an ABF position on the far side. If the complex obstacle system contains more minefield, the plow tank waits until dismounted infantry reaches it and passes through the later minefield; then it engages its plow and continues to breach. The dismounted infantry pass through the lane immediately after the firing of the second MICLIC to secure the far side of the obstacle.

The variety of reduction techniques is virtually unlimited and depends on the initiative of the dismounted soldier. Most techniques involve common hand-tools such as shovels to knock down the sides of AT ditches, wire cutters to cut barbed wire, and axes and chain saws to cut logs and trees. These techniques will not be discussed because there are so many of them. However, the breacher should be aware of and capitalize on all the simple ways he has available to get the force through the obstacle.

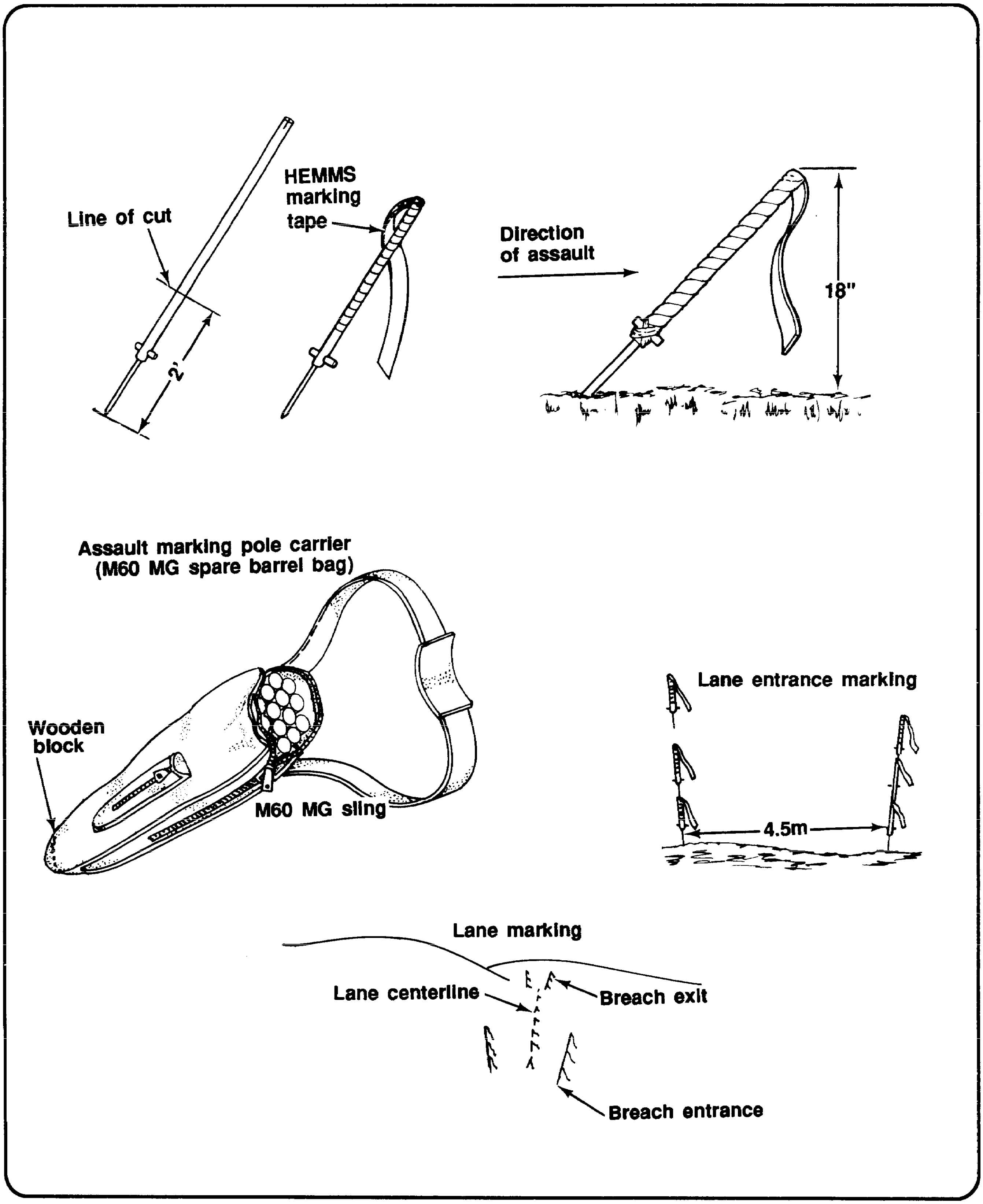


Figure C-14. Modified HEMMS lane-marking system.