A BRIEF SURVEY
OF
MINE BREACHING CAPABILITIES

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INTRODUCTION

This brief survey was written at the request and funding of Mr. Mark Perry of the Vietnam Veterans of America Foundation. The survey represents the opinion of The Dupuy Institute, based upon its analysis. The contents, analysis and conclusions of this study are entirely those of the Institute.

The study is primarily the work of Christopher A. Lawrence, Executive Director of The Dupuy Institute, and Richard C. Anderson, Institute Historian. Nicholas Krawciw, Major General, USA, Ret., President of The Dupuy Institute, provided his knowledgeable commentary and support.

THE ISSUE

> ***The capability to rapidly breach obstacles has evidenced almost no improvement since World War II. Techniques in use are conceptually the same as those used in the 1940s. --*** *US Army After Action Report for Operation Desert Storm*

US Army doctrine is based fundamentally upon utilizing dominant offensive maneuver to achieve a decisive result in battle. In this doctrine anything that slows the pace of operations is bad, while anything that facilitates the pace of operations is good. Thus, obstacles – whether natural or man-made – that inhibit maneuver are bad.

US Army commanders decided not to make use of defensive mine warfare in the Persian Gulf War (Operation DESERT SHIELD). This decision was in line with their intention to attack. Mines are an asymmetric threat that can neutralize US Army capabilities and inhibit the execution of Force XXI doctrine. An effective antipersonnel mine ban would be supportive of current US Army doctrine.

The Army is searching for weapon systems and technologies that will enable soldiers to best maintain the increased pace of future operations. The Grizzly Breacher clearly adds capabilities to the to the Army's ability to conduct offensive action and maneuver. Unfortunately, as of December 1999 the US Army as part of Program Budget Decision No. 745 canceled production of the Grizzly. The cancellation eliminated the first fully integrated obstacle clearing vehicle developed for the US Army, leaving the Army dependent on fifty-year old technology to support Force XXI doctrine.

There is a contradiction here. The US Army's objection to the Ottawa Antipersonnel Mine Ban Accords is that it feels that antipersonnel mines are essential to helping defend Korea and are necessary for effective mixed munitions systems (mixed systems are those mine delivery systems that incorporate a mixture of antipersonnel and antitank mines). However, an effective antipersonnel mine ban would only aid the US Army in the execution of Force XXI doctrine. The only weapon system that can enable the Army to quickly and easily breach obstacle barriers has been canceled.[1]

The US Marine Corps also has expressed a strong interest in breaching operations. This is primarily due to their concern over conducting operations across defended beaches, in addition to the usual concerns about obstacles in ground operations. Once the Marine Corps is ashore, they

[1] There has been some suggestion that the de facto cancellation is only in fact a delay. However, the practical result will still be a serious delay -- of at least two years -- in the deployment of Grizzly.

must cope with the same types of land-based barriers and mines encountered by the US Army. Thus, the Marines have the same breaching requirements as the US Army. Although it was primarily an Army development project, the Marines had hoped to save some expenses by participating in this project.

Grizzly is an expensive system, which is its primary drawback. The question then is whether or not the cost of Grizzly is worth its possible benefits. This paper cannot give a definite answer to that question. Rather, the purpose of this analysis is to provide a background on current breaching capabilities, and a real world measurement of the speed and effectiveness of breaching operations. We will review and analyze breaching operations conducted by US forces in a number of historic cases over the past fifty-six years. From these examples we will attempt to determine the time required for a breaching operation, using current and past technologies.

Unfortunately, since no similar system has ever been deployed by the US Army, we do not have a comparable real-world example of breaching operations using Grizzly. Thus, this study will examine the test measures and the reported improvement in breaching time cited for the Grizzly. This test data, will be viewed with a jaundiced eye.

From the analysis we hope to be able to develop a measure of the importance of breaching effectiveness in military operations. This may help determine whether or not there is sufficient value in the Grizzly to warrant a review of the decision to cancel it.

BACKGROUND

The Grizzly is a dedicated obstacle-clearing vehicle, designed to allow quick clearance of obstacle systems and minefields. The Grizzly is based on the M1 tank chassis, giving it excellent protection and mobility, as well as parts commonality with the M1. The Grizzly incorporates a full width mine-clearing blade, allowing it to quickly and completely clear mine free lanes and a power driven arm for obstacle reduction and digging. For defense, it has a .50 caliber machine gun and a smoke grenade launcher. It has a crew of two.

The US Army Grizzly program is designed to provide an up to date breaching capability to both the US Army and the US Marine Corps. Currently, both the US Army and the US Marine Corps use similar methods and systems for breaching, systems that have remained virtually unchanged for fifty years.

On 27 December 1999, the planned purchase of 366 Grizzlies was canceled under Program Budget Decision No. 745, and the program was placed into hibernation. However, as of August 2000 it appears that a decision has been made to resuscitate the program in the near future. Under this new plan it appears that a smaller number of systems – about 168 Grizzlies – will be procured. In any case, it appears that any deployment of Grizzly will now be delayed until sometime after fiscal year 2005.

Planned Employment of Grizzly

The original US Army Basis of Issue Plan called for 12 Grizzlies per engineer battalion (36 per Heavy Division Engineer Brigade and 12 per Engineer Battalion Corps (M)), and six per Separate Engineer Company (in the Engineer Company, Armored Cavalry Regiment and Separate Brigade). The Army of Excellence engineer brigade consisted of 1,389 soldiers organized into three battalions of 444 each and a headquarters of 57. The revised Force XXI organization replaces the engineer brigade with three separate engineer battalions of 312 soldiers each and a division engineer planning section of 28 for a total of 964 soldiers, a personnel saving of 425. The deployment of Grizzly with its two-man crew would facilitate this reduction in the personnel strength of engineer battalions in Force XXI.

The Army of Excellence engineer brigade would have had 36 Grizzlies, 36 Wolverines (a replacement for the Armored Vehicle Launched Bridge or AVLB, which has also been canceled), 63 M9 Armored Combat Earthmover (ACE) and 36 Mine Clearing Line Charge systems (MICLIC). The planned organization for the Force XXI engineer structure was also for 36 Grizzlies, 36 Wolverines, 36 ACE and 18 MICLIC. Both of these plans required an Army Procurement Objective (APO) of 366 Grizzlies. It appears that under the new – and as yet unofficial – APO, plans call for 18 Grizzlies per heavy division and a total purchase of 168.

Note that Grizzly was not considered for the Army's light divisions. However, it may be questioned, in light of the Army's reluctance to agree to the Ottawa Accords, why there appears to be so little concern for the vulnerability of these light divisions to landmines? If it is believed by the Army that antipersonnel mines are such a force multiplier that are an absolute necessity in Korea, why is not the corollary – that they can be used against the US Army as an equally decisive force multiplier – also believed by the Army?

The Marine Corps planned on purchasing 18 Grizzlies for Marine Corps Engineers and for the Maritime Prepositioning Force as an add-on to the Army buy, a fraction of the US Army purchase.

Grizzly Capabilities

According to official documents, the Grizzly is capable of breaching a 600-meter complex obstacle in 21 minutes and an antitank ditch in 5 minutes. Reportedly it is 60 percent faster than current breaching tactics. Grizzly is reported to incur 40 percent fewer casualties, it is 60 percent more survivable than existing breaching systems and it has an exercise success rate of 71 percent versus 19 percent for current breaching means. Without review of the actual test data, The Dupuy Institute cannot comment on the accuracy or applicability of such measurements except to say that they usually are derived from static test measures and from simulations that typically fail to represent the full range of conditions found in combat.

Perhaps the most useful comparison was that between current breaching means and Grizzly. The Army claims that the Grizzly will significantly reduce complex obstacle breaching times and resources required. Current methods require 31 to 45 soldiers, nine vehicles and take two and one-half to eleven and one-half hours to complete. It is claimed that Grizzly can execute the same breach in 21 minutes using four soldiers with two Grizzlies.

The Grizzly's primary features are a 4.2-meter full-width mine-clearing blade (MCB) and a power arm. The power arm has a reach of 9 meters and a bucket capacity of 1.2 cubic meters. The power arm's primary mission is to reduce berms and log or steel obstacles, and to fill antitank ditches and craters. The MCB lifts and pushes mines – both surface laid and those buried up to 31 centimeters (12 inches) – to the side in a full-width (as opposed to a track-width), 4.2 meter-wide cleared lane. When plowing, the Grizzly's speed is restricted to less than 10 KPH.

Current Breaching Methods and Equipment

The current US Army method of mine clearing, as outlined in a US Army engineer white paper, requires the use of a battalion countermine set. It includes six sets of track-width mine plows and two sets of track-width mine rollers. These are attached to eight main battle tanks, converting them to non-firing breaching vehicles (the gun tube must be traversed to the side or rear to prevent damage while clearing mines). As such, 33 percent of the combat power of a

typical battalion task force (8 of 24 tanks) is temporarily unusable.

The US Army and the US Marine Corps use the MICLIC as the primary mine breaching method for both hasty and deliberate breaching operations. The MICLIC is effectively a tube of explosives that is fired across the area to be breached and then exploded. Each MICLIC contains 1,750 lb. of C-4 explosive and is 105 meters long. The explosive charge is anchored by a rope to give a 62 meter standoff distance from the charge.

The MICLIC creates a lane approximately 90 meters deep and 14 to 16 meters wide. Within this zone, the MICLIC detonates 92 to 95 percent of the mines that are surface-laid or buried up to 2.5 centimeters. Deeper buried mines are less likely to detonate, as are certain types of purpose designed magnetic influence, standoff, and blast-hardened mines. The basic concept of the MICLIC is over fifty years old and is a development of the World War II US Army Engineer SNAKE mine clearing device.

In the US Army, the MICLIC is either trailer mounted – with one MICLIC – or is mounted in pairs on an AVLB, which has had the bridge removed. Known as an AVLM, this latter must be prepared in advance. Towing vehicles for the trailer mounted MICLIC include the M113 Armored Personnel Carrier (APC), the M9 ACE, or 5-ton or 2-ton trucks. Reloads for the MICLIC are carried in 5-ton trucks. The reloading can be done in as little as 20 minutes.

In the US Marine Corps, the MICLIC is either mounted as the Mk154 on the Amphibious Assault Vehicle (AAV) or as the Mk155 on a trailer. The Mk154 mount contains three MICLIC. The Mk155 mount contains one MICLIC and weighs 6,405 lb. For breaching operations, more than one Mk155 trailer will usually be on site. The Mk154 can breach a single lane of up to 270 meters in length in three shots.

There are some limitations to use of the MICLIC. In jungle or woods, the tree canopy can interfere with use. High winds can also prevent a straight shot. The biggest problem is that the MICLIC does not always detonate on command. This requires the operator to dismount and expose himself to enemy fire to manually detonate the charge. If the charge still does not explode, then another MICLIC must be brought up and used. Furthermore, the MICLIC, consisting of nearly a ton of high explosive, could be vulnerable to enemy fire.

Since the MICLIC will not reliably detonate all of the mines in a lane, the lanes must be proofed with mine clearing plows and/or rollers. Both the US Army and the Marine Corps use the M1 tank with a track-width plow for mine clearing. The US Army plow is the Mine Clearing Blade (MCB), the Marine Corps plow, which is similar, is the Track-Width Mine Plow (TWMP).

The US Army MCB is used to remove land mines to create or proof a lane in a minefield. The MCB lifts and pushes mines, which are surface-laid or buried up to 31 centimeters deep, to the side of the track-width lanes. The blade creates a 1.5-meter clear path in front of each track.

A major defect of track-width systems is that an area between the tracks remains uncleared. The blade may be destroyed during mine clearing by exploding mines. It weighs about 3,150 kilograms (around 3.5 tons) and can be mounted on an M1 tank without special preparation or modification. Mounting the MCB requires lift capability[2] and takes up to an hour, so it must be done well in advance of the clearing operation. The tank, with the MCB raised, is not significantly degraded in combat capability. The Army manual points out that 15 percent of pressure-fused AT mines encountered by the MCB can be expected to detonate under the skid shoe, probably disabling the blade. The MCB is also vulnerable to coupled mines and may be stopped by log-hurdle obstacles placed in a minefield that are part of a complex obstacle.

The Marine Corps TWMP lifts and pushes surface laid or buried mines up to 4 inches deep in front of its path. The TWMP weighs around 3 tons. When the TWMP is installed, the M1 is reduced to a maximum speed of about 10 kilometers per hour. If moved an extended distance the TWMP are brought up on transporters and then installed. Furthermore, the M1 with the plow installed may exceed the load capacity of the current armored vehicle launched bridge and could cause extensive damage. The plow has an emergency disconnect. Mounting the plow takes time and it cannot be easily mounted or transferred to another tank under battlefield conditions.

Also available for use by the Marines is a heavier Mine Clearing Blade System. It is designed to effectively counteract and neutralize all land mines and is capable of clearing surface or buried mines up to 2 meters in front of the tanks' path without the aid of supporting forces or additional equipment. It weighs 4.5 tons.

The primary limitation in using both types of mine plow is that the tank it is mounted on is no longer a combat asset. To prevent damaging the gun tube while clearing, it is traversed to the side or rear. For most practical purposes, the M1 tanks mounting the MCB are not available for combat. In an Army battalion task force this means that up to eight of its 24 (33 percent) main battle tanks may be unavailable during breaching operations.

Mine clearing rollers (MCR) are also available, but these are intended primarily for detecting rather than clearing minefields. A secondary use of mine rollers is to proof lanes created by other means. However, they are not a good system for minefield reduction, because the rollers will normally withstand only two mine explosions. A roller can be mounted on M1 tanks modified with the permanent attachment of the mine roller mounting kit. Mounting the roller takes time and is difficult under battlefield conditions. The roller weighs more than 10 tons and greatly reduces the tank's maneuverability and speed.

The US Army MCR weighs 9,072 kilograms. The roller creates a 1.1-meter wide cleared path in front of each track. Like the plow, it also leaves an uncleared area in the middle of the

[2]This is the terminology used in FM 3-24.2, Appendix C, Obstacle-Reduction Techniques. It is assumed that hydraulic or mechanical jacks or lifts are meant.

cleared area that must be avoided. Installing rollers requires lift capability and takes from 30 to 60 minutes to fit to a tank that is already fitted with a mounting kit.

Since defensive obstacles usually consist of more than just mines, obstacles and gaps must be breached using the ACE, which effectively is an armored bulldozer. Wire obstacles must be removed by hand using wire cutters or with bangalore torpedoes. The ACE requires one operator, travels 30 mph on land and swims at 3 mph in calm water. It is used for obstacle clearing and entrenching and has limited utility in mine clearing operations. The US Army and Marine Corps also employ standard, unarmored D-7 bulldozers. There are armor kits that can be added to them to protect the bulldozer and driver from small arms fire and shrapnel. Sand bags and other improvised armor can also be used. Bulldozers can be used effectively in clearing SCATMINEs and antipersonnel minefields. However, the Marine Corps manual specifically states that using a bulldozer plow should only be used as a last resort for removing surface and shallow buried mines.

The US Army Full-Width Mine Rake (FWMR) can be attached to a bulldozer and gives the ability to clear antitank mines from a 15-foot wide lane, but may leave antipersonnel mines in the clear path. It is effective in sandy or loose soil and plows to a depth of 12 inches. The Army combines the FWMR with an armor kit to create a mine-clearing/armor-protection (MCAP) kit for the D-7 bulldozer.

The Army also has developed a remote-control mini-flail, which is effective against antipersonnel mines. Unfortunately, antitank mines can destroy it.

The US Army has also experimented with a vehicle called the Panther, which was used during Operations Joint Endeavor and Joint TF Eagle in Bosnia. The system consists of a turretless M60 tank, Israeli-designed mine rollers, an antimagnetic actuating device and a remote control unit that is mounted on a separate vehicle (usually an M113). It also mounts a remote video camera allowing the operator to see ahead of the vehicle.

Various other man-portable reduction assets are available, including the Anti-Personnel Obstacle Breaching System (APOBS) which effectively is a man-portable MICLIC, the bangalore torpedo, metal detectors, manual probing, grappling hooks, demolitions, and so on. For all practical purposes, mine-clearing methods in the year 2000 are not significantly changed from those developed in World War II.

All of these mine and obstacle reduction functions can be done by the Grizzly alone.

A Comparison

A comparison is shown in the Grizzly program office briefing[3] of the use of existing breaching systems versus the Grizzly, in breaching a 600 meters complex obstacle. In the example, the complex obstacle consists of 100 meters of open ground, a wire obstacle, and a mixed antitank and antipersonnel minefield several hundred meters deep, an antitank ditch, a berm, more mines and finally 100 meters of open ground.

Using the existing systems, the operation begins with reconnaissance elements discovering the obstacle. One hour after discovery, the concept for executing the breach is developed. Three hours after discovery, the breaching task force operations order is issued. Five hours after discovery, the fire support elements and breaching equipment are assembled. Six hours after discovery, rollers and plows are installed on breaching vehicles and rehearsals with team leaders are done. Eight hours after discovery, the force moves to attack positions. Nine hours after discovery, fire support begins and at nine and one-half hours the breaching force crosses the line of departure. At ten hours, dismounted sappers defeat the wire obstacles with bangalore torpedoes and cutters. Fifteen minutes later the MICLIC is deployed and fired to clear a lane. After another 15 minutes, the MCB and MCR proof the lane. Fifteen minutes later, lane marking begins. Having crossed the minefield, an AVLB is brought up to bridge the tank ditch (or an ACE is used to reduce it). Fifteen minutes later, sappers or the M1 MCB clear the far side of the tank ditch. Eleven and a one-half hours after the obstacle has been discovered, the breach is clear.

This example requires 20 soldiers and an array of breaching and reduction devices. It shows that it can be reasonably assumed that it could take up to nine and one-half hours ***before*** the breaching force is ready to cross the line of departure, and that it only requires two hours for the actual execution of the breach. As shown from the historical examples, from two to eleven and one-half hours to breach an obstacle barrier accords with real world experience, although in most of the operations studied an effective breach was completed within seven and one-half hours.

For the Grizzly, the same briefing postulates that only one-half hour after the obstacle is discovered the commander has developed his concept. One hour after discovery, he issues the task force FRAGO. At one and one-half hours, he has alerted fire support. At one hour and 45 minutes, the force has moved to attack positions, and at two hours, fire support begins, simultaneously, the Grizzlies cross the line of departure.

The example assumes a saving of one-half hour to develop the concept, one and one-half hours to issue the FRAGO, one hour and 15 minutes to move the force to attack positions and one-half hour for fire support, since the Grizzlies leave the line of departure the moment the fire

[3]TACOM Briefing "Why A Grizzly," dated 3/12/98, by Donald P. Kotchman, Lt. Col., Ordnance, Product Manager.

support is initiated. The timesaving may be justified by the improved command and control offered by the digitization of the Grizzly, and may also be justified by the much less complex planning required for a Grizzly breach operation. Even if the timesaving gained by the Grizzly digitization were not in place, the time saved before the operation begins could still add up to several hours. The actual breaching time by the Grizzly is 21 minutes, as opposed to two hours. Four crew in two Grizzlies – under armor – are committed to the Grizzly operation, rather than the 20 – many of them exposed to enemy fire – with the array of devices required in current operations.

Overall, the example shows that eleven and one-half hours are required with the old methods, while the Grizzly requires two and one-half hours. TDI has no quibble with the time estimates for existing breaching methods (although the estimates may actually be a little high); the Grizzly breaching time may be optimistic. Still, the ability of the Grizzly to quickly clear through obstacles with less complicated preparation and planning certainly reduces exposure and therefore could reduce losses, could quicken and ease breaching operations, and could increase surprise.

The US Army Requirement

The US Army currently has 10 divisions. Of these, five are heavy divisions (armored or mechanized), one is a “medium” division (the two-brigade 2nd Division in Korea), two are light divisions, one is an airmobile division and one is an airborne division. The heavy division has a need for obstacle breaching capabilities that will keep pace with the increased tempo of operations and maneuver as outlined in the Force XXI doctrine.

Under the original APO of 366 Grizzlies, it was not planned to deploy it in the other five divisions, although the Engineer Battalion Corps (M), the Separate Engineer Company (Armored Cavalry Regiment), and the Separate Heavy Brigades were to receive it. Under the still speculative revised APO of 168 Grizzlies, 90 will probably still be with the heavy divisions (probably including the 2nd Division), leaving 78 for corps assets, training, and replacements.

The US Marine Corps Mine Problem

The Marine Corps has a more complicated mine problem, as it must consider breaching minefields in potentially five different zones in amphibious operations. Marines must deal with deep-water mines at depths of more than 200 feet, shallow-water mining (40 to 200 foot depth), and very shallow-water (10 to 40 foot depth). None of these three zones rely on land warfare type breaching systems and therefore are not a subject of further discussion.

The surf zone, which is the area from the high water mark to a 10-foot water depth, is an area where land warfare breaching assets may have some utility. The mines that might be found include bottom-contact mines, bottom-influence mines, bottom-pressure plate mines, ground tilt-

rod mines, moored contact, moored influence, and anti-invasion mines. Mines mixed with obstacles can complicate the mine clearance problem.

Finally, the Marines have the same needs for land warfare breaching capability as the US Army. The US Marines have not conducted an amphibious operation that required extensive breaching support since 1950. They did conduct extensive land-based breaching operations in the Gulf War in 1991 with both deployed Marine divisions. As such, the Marine Corps need for breaching assets is as important as that of the US Army.

Hasty versus Deliberate Breaching

Marine Corps breaching doctrine stresses the differences between hasty and deliberate breaches, dedicating a separate chapter to each of them in its manuals.

For a hasty breaching operation, a mechanized battalion task force should plan to create a minimum of two lanes. The obstacle reduction teams will mechanically, explosively or manually reduce the obstacles. Quick removal of mines is accomplished by the MICLIC. The Marine Corps uses two MICLIC platforms, the Mk154 and the Mk155. After the MICLIC blast has cleared a lane, M1 tanks mounting plows proof it. Non-explosive obstacles will be reduced using the ACE, demolition charges and manual means. The primary method of spanning tank ditches is to use the AVLB. The alternate method will be to fill in the ditch by using the ACE or by placing pipe fascines in the ditch.

The actual MICLIC line charges are fired from the Mk154 or Mk155 over a protecting M1 tank with an attached plow. Two more M1 tanks with TWMP will follow up to proof the minefield. Total resources for mine clearing one lane are one Mk154 or two Mk155 and three M1 with TWMP. One M1 with a TWMP is used to shelter the MICLIC while two are used to proof the minefield. As two lanes are desired per battalion, then battalion-level requirements are doubled.

For deliberate breaching, it is recommended that a minimum of two lanes be created per regiment, although two lanes per battalion are ideal. Breaching methodology is not described in detail in the Marine technical manuals, but is clearly intended to be similar to hasty breaching. However, with the leisure of longer planning times, one is able to configure forces to fit the specific situation. Regardless, it is expected that breaching team that do not relying heavily upon manual removal of obstacles and mines will be similar in organization to those used for hasty breaching.

HISTORICAL BREACHING OF AN OBSTACLE BARRIER

US Army Breaching Operations in Operation OVERLORD, 6 June 1944

As part of the plan for Operation OVERLORD, the US Army was required to establish two beachheads on the Norman coastline of France on 6 June 1944. Each beachhead was assigned to a single corps, the VII Corps on UTAH Beach and the V Corps on OMAHA Beach. The assault on UTAH was to be by a single division, the 4th Infantry. The assault on OMAHA was to be by two infantry divisions, the 1st and the 29th.[4]

Defense on the tidal flats included wood and steel obstacles, many with antitank mines attached. Seawalls, antitank ditches and antitank mines obstructed exits from the beaches. The few antipersonnel mines available were used to cover approaches to the strongpoints. UTAH Beach was very flat, typically 900 meters from the high water to low-water line. Flooded fields obstructed exit from the beach. Six raised roadbeds (which were called causeways by the planners) were left as access to the interior. The beach at OMAHA was steeper, about 400 meters from the high-water to low-water mark, and was backed by sharp bluffs that rise over thirty meters above sea level. Exit from the beach was by five ravines or draws, only one of which featured a hard paved road. On both UTAH and OMAHA, exit from the beach was further obstructed by naturally occurring shingle, which reduced traction for both tracked and wheeled vehicles.

Reconnaissance photos of the beaches, taken in February, did not show dense concentrations of obstacles and Allied planners did not focus engineer resources on breaching. However, by March photos revealed a dramatic increase in the number and density of obstacles. The response was to create two engineer task forces, specifically assigned to clear the obstacles from the beaches. Obstacles were to be cleared initially by hand, using 10-pound blocks of high explosive and 20 and 40 pound satchel charges. Tank dozers and bulldozers were to push aside obstacles and debris and fill in ditches and craters. Mines were to be removed from obstacles or blown in place. Mine clearing on the beaches and dunes was to be done by probing and with electronic detectors, with the mines being removed by hand or detonated in place as was appropriate.

[4]Technically, the 116th Infantry of the 29th Division was attached to the 1st Division for the assault phase. Effectively, however, this was a two division assault, initially executed by a single regiment from each division.

UTAH Beach, H-Hour 0630

The plan for UTAH Beach placed breaching assets in the 2nd landing wave (H+5 minutes). They included approximately 300 men, including Navy Underwater Demolition Units (NUDUs) and Army engineers of the 237th and 299th Combat Engineer Battalions, which together formed the Beach Obstacle Demolition Party. Their mission called for clearing eight 50-yard wide lanes. Four tank dozers manned by the 70th Tank Battalion was to assist the breaching operation until bulldozers could be landed.

The actual landing was executed on time at 0630 hours. However, a number of circumstances resulted in the actual landing site being some 1,500 meters south of the planned location. This proved fortuitous inasmuch as the obstacle density at the actual landing site was lower than at the planned site. The engineer landing was also affected by the same problems and arrived 12 minutes late. Unfortunately, effective artillery fire inflicted heavy casualties just as the boats hit the beach, killing six and wounded 39 of the Army engineers and killing four and wounding 11 in the Navy demolition teams. Thus, approximately 20 percent of the Beach Obstacle Demolition Party were lost in the first few minutes of the invasion.

Despite the casualties the engineers made significant progress. The flat beach meant that the tide advanced so slowly that by H+60 the decision was made to ignore lanes and simply clear the entire beach of obstacles. Less than an hour later, before 0830, the majority of the obstacles had been cleared from the beach. Also at this time, the first breaches in the seawall were made and work began on laying matting over the shingle and dunes.

Follow-on waves of engineers continued to land throughout the day and executed an engineer reconnaissance of the beach exits, lifted mines from the causeways and dunes, and, in one case, emplaced a treadway bridge over a demolished culvert. By about 2130 hours approximately 20,000 troops and 1,700 vehicles had been landed, the causeways had been cleared and contact had been established inland with elements of the 101st and 82nd Airborne Divisions.

Casualties on UTAH Beach were light. The 1st Engineer Special Brigade lost 21 KIA, 96 WIA. The 4th Infantry Division lost 12 KIA, 125 WIA, and 60 MIA. An additional 2 KIA and 17 WIA were incurred from mines by units clearing the St. Marcouf Islands offshore. Altogether, the V Corps suffered fewer than 400 casualties on D-Day, with almost one-third being from the engineer forces.

In summary, it may be said that the UTAH Beach landing benefited from luck and the weakness of the German defenses. Most of the beach obstacles were cleared, the seawall was breached and access to the causeways inland were all achieved. Overall, it may be said that the German defenses were effectively breached within three hours of the initial landing.

OMAHA Beach, H-Hour 0630

The plan for OMAHA Beach differed in scale and detail from that for UTAH Beach. On OMAHA, the initial breaching was the responsibility of the Special Engineer Task Force, composed of 16 Army-Navy teams each of 41 men with 1,000 pounds of explosives, one dozer tank. They were to land at H+3 minutes and clear 16 gaps in the beach obstacles. Follow-on engineer waves would breach the obstacles guarding the beach exits. Note that the tasks required and the assets allocated on OMAHA were about twice those on UTAH.

Unfortunately, the obstacle density was much higher on OMAHA than on UTAH. Worse, the tide also advanced much faster than on UTAH. The demolition teams would only have a maximum of 30 minutes to clear obstacles before the returning tide impeded operations. Compounding the problem was the stronger active defenses on OMAHA. German strongpoints in the beach exits and on the bluffs had excellent visibility and were able to enfilade the landing sites.

As a result, the Special Engineer Task Force suffered heavy casualties on the approach and on landing. Landing craft were sunk by mines and by gunfire, personnel were drowned and hit on the beach by effective machine gun, mortar and artillery fire. Navy personnel lost 52 percent (about 108 men), the 146th Engineers lost 34 percent (about 68 men), and the 299th Engineers 41 percent (about 82 men), for a total of about 268 men. In addition, 10 of the 16 tank dozers were lost in the approach, 3 more were lost on the beach. Only five of 16 gaps were cleared, and only one of those was marked and useable at 1st high water (1036 hours), four hours after landing. It wasn't until 2nd low water (1745 hours) over 11 hours after landing, that the Task Force was able to clear and mark a total of 13 gaps.

From H+40 minutes on, additional waves of engineers were landed, by evening a further nine battalions were committed to the assault. Their task was to clear the beach exits by demolishing the sea wall and filling the antitank ditches, clear mines and facilitate movement over the shingle. Progress was slow, hampered by heavy losses in men and equipment.

Engineering work began at Beach Exit D-1 at 1400 hours when the sea wall was demolished. It was opened to traffic by 1800 hours. At Exit D-3 work began sometime in the afternoon and it opened to traffic at 2000 hours. At Exit E-1 work began before 1100 hours and it opened to traffic at 1500 hours. At Beach Exit E-3 work began at 2100 hours and it opened to traffic on the morning of 7 June. At Exit F-1 work began at 1700 hours and also was not completed until 7 June.

Casualties to the nine follow-on engineer battalions were heavy. Data is incomplete, but it is known that four suffered at least 147 casualties (121st Engineers, 61 casualties; 1st Engineers, 4 KIA, 23 WIA, 6 MIA; 37th Engineers, 24 KIA; 336th Engineers, 2 KIA, 27 WIA). Exact totals for the V Corps losses on OMAHA Beach will probably never be known, but were at least 2,000

killed, wounded and missing, with the engineers suffering about one-quarter of the total.

In summary, the OMAHA Beach landing suffered heavily from bad luck and stiff German resistance. Although none of the final objectives for D-Day were reached, a tenuous lodgment had been effected. By the end of day thirteen lanes through the beach obstacles were cleared and marked and three of the five beach exits were open to traffic. Overall, it may be said that the German defenses were effectively breached within seven and one-half hours of the initial landing.

Persian Gulf, 1991: Operation DESERT STORM

The breaching operations undertaken in DESERT STORM were mainly oriented to clearing minefields and spanning antitank ditches. The problems associated with an amphibious assault were not encountered, although soft sand probably caused mobility problems similar to those found with the shingle of the Normandy beaches. Fundamentally however, the major difference was the lack of effective resistance put up by Iraqi forces. Combined Coalition casualties in executing the entire ground phase of the war were fewer than those suffered by the US V Corps in the "easy" operations on UTAH Beach.

Breaching operations were executed by the 1st and 2nd Marine Divisions and by the 1st Infantry Division. The Marine breaches were utilized for the passage of those divisions only; the Army breach was to be utilized by the 1st UK Armored Division as well.

USMC Breaching Operations

The 1st MarDiv took from 0400 to 1030 hours (6.5 hours) to clear 14 lanes through the minefields. Actual breaching times for the first belt was 24 minutes, for the second belt it was 15 minutes. Casualties were one killed and nine wounded, while three M60A1 (one of which, a mine plow, was destroyed) and one LAV were disabled.

The 2nd MarDiv breaching operation was more complicated. The division deployed 247 tanks, 183 M1A1 and 64 M60A1; six of the M60A1 had TWMP. Six lanes were opened in the first belt of mines, requiring 2.5 hours to open four of the six and 7.75 hours to complete all. It took from 0600 to 0724 hours to open lanes Red 1 and 2, from 0615 to 0724 hours to open lanes Blue 3 and 4, and from 0615 to 1145 hours to clear lane Green 5. In the sixth lane, Green 6, several vehicles were lost and the original lane was abandoned. Work on this lane was shifted to a new location and between 0615 and 1345 hours the new Green 6 was cleared. In the second belt of mines four lanes were opened. Between 0724 and 0745 hours lanes Red 1 and 2 were opened and between 0724 and 0850 hours Blue 3 and 4 were opened. Total casualties were two killed and 12 wounded (of which four WIA appear to have been due to mines). Equipment losses were seven M60A1 (at least four of which were mine plows), two AAV, and one M1A1.

It should be noted that in the detailed accounts available of the Marine breaching

operations, there is not a single reported instance of the MICLIC detonating on command. In every case found, an operator was forced to dismount and expose himself to enemy fire in order to detonate the charge. Luckily, it does not appear from the published accounts that any of the operators were killed or wounded while attempting to detonate the MICLIC charge.

US Army Breaching Operations

The 1st Infantry Division plan allocated 18 hours for completing 24 breach lanes. The actual time required was two hours (from 1500 to 1600 hours 16 lanes were cleared and by 1654 hours all lanes were cleared).

The equipment that was required for the 1st Division breaching operation included 13 mine clearing battalion sets and 43 CEV mine rakes. A total of 99 M9 ACE were used. One engineer was wounded during the operation.

Overall, the most concise assessment of the Coalition breaching operation was made by General James L. Jones, Commandant of the Marine Corps, in his keynote address to the 4th Symposium of the Mine Warfare Association,

> ***Regarding land mines, I see this complacency perhaps beginning to grow... our Gulf War success, which was more a function of the Iraqi inability to maintain their minefields and cover them with fire, as well as their basic ineptitude, than it was a testament to our mine clearing expertise.***

Total casualties among the three divisions executing breaching operations in DESERT STORM were three killed and 22 wounded. Total casualties in the 100-Hour War for the two Marine divisions were six killed and 34 wounded. Twenty-four (60.0 percent) of the total Marine casualties in the ground phase were incurred during breaching operations, including fifty percent of those killed (three) and 61.8 percent of those wounded (21). It is also known that Marine Corps casualties in the Gulf totaled 177, of which seven (four percent) were attributed to landmines. If all the mine casualties were incurred in the breaching operation, then one-third of those wounded while breaching were lost to mines. A total of 11 tanks were destroyed or damaged in the breaching operation, probably all to mines. It appears that one of the eight M1 tanks damaged or destroyed in DESERT STORM (12.5 percent) was lost in these breaching operations, it appears that all ten M60 tanks lost in DESERT STORM (100 percent) were damaged or destroyed in the breaching operations.

Comparison, Operations OVERLORD and DESERT STORM

The most remarkable similarity between OVERLORD and DESERT STORM is that the time required to complete breaching operations was so similar. The fastest breach was that of the 2nd MarDiv – one and three-quarter hours – although it was almost eight hours before the breach

was completed. The 1st Infantry Division in DESERT STORM was next at two hours, followed by UTAH Beach at three hours. Then there was a wide gap with the 1st MarDiv in DESERT STORM requiring six and one-half hours to complete its breach. Last was the breaching operation on OMAHA Beach at eight hours.

Also similar in these six division breaching operations (4th Division on UTAH Beach, 1st and 29th Division on OMAHA Beach, 1st Marine Division, 2nd Marine Division and 1st Infantry Division in DESERT STORM) was the number of breach lanes planned for each division. Eight lanes per division were planned for in each of the three cases from World War II. In the case of DESERT STORM, the 1st MarDiv planned on 14 lanes, the 2nd MarDiv on 10 (six in the first and four in the second mine belt) and the 1st Division planned for 24 (to allow for the possible requirement to pass two or three divisions through the obstacle belt). It appears that about eight lanes per division is the practical norm in planning and executing a breaching operation. Effectively, the doctrinal requirement for an ideal of two lanes per battalion is matched by the historical practice.

What are most dissimilar are the casualties. Losses in all three of the breaching operations in DESERT STORM totaled 25, fewer casualties than were suffered by one of the 41-man demolition teams on OMAHA Beach. It may be speculated that, given the difficulties encountered with the MICLIC system in DESERT STORM, the casualties of the US Army and Marine Corps engineers could easily have been much higher if Iraqi resistance had been only slightly more effective.

TENTATIVE CONCLUSIONS

It appears that the Grizzly is the right system for the mission and that it fits the US Army and US Marine Corps requirements and doctrine. The issue that appears to have torpedoed it is cost. Much of the cost was driven by the large purchase of 366 Grizzlies, which was driven by the planned allocation of 36 per heavy division. The revised -- and currently unfunded -- APO for 168 Grizzlies would allow for 18 Grizzlies per heavy division. The question then is whether or not the Army can accept the fewer number of Grizzlies for the sake of getting some, rather than none, of the benefits of Grizzly.

First, one must decide where the Grizzly is most useful. It is our conclusion that the Grizzly is most useful in executing a hasty breach. As the deliberate breaching operation is planned ahead of time, then in many cases, the much slower tempo of the existing mine clearing systems can be compensated for by advanced planning. In effect, making sure that the breaching operation begins early enough so to not hinder the pace of the offense can eliminate some of the time lost in current breaching methods. Furthermore, the problems associated with the complexity of current breaching methods can be somewhat mitigated by the detailed planning involved in a deliberate breaching effort. Certainly, the example of the breaching operations in Normandy show that extensive preparation can result in success, despite the lack of specialized equipment, albeit at the cost of tremendous casualties. Still, this is no way lessens the considerable advantages of Grizzly, including the reduction in the actual time spent executing the breach, the ability to operate Grizzly under armor, and the lower number of personnel exposed in Grizzly, all of which could result in lower casualties and less warning time for the enemy.

It is in hasty breaching operations that the Grizzly excels. Here its speed and ability to keep pace with the mechanized advance is important. Its rapid breaching capability enhances surprise while lowering casualties. It is the only single system that is likely to complete a breach unaided and it requires fewer resources from combat elements to accomplish its mission. It is the ideal vehicle for creating hasty breaches. Furthermore, because of the tempo of operations, using the Grizzly, obstacles that in the past would have required a deliberate breaching effort may in fact be dispensed with as part of hasty breaching operation.

However, one should examine the rationale behind having 18 (or for that matter the original 36) Grizzlies per division. A heavy division has three brigades and nine maneuver battalions. Each battalion in a breaching operation would plan to clear at least two lanes. Assuming that two Grizzlies are used per lane (with the procurement revision currently under discussion it appears that it may now be planned to use one Grizzly per lane, so as to reduce the overall number required), then four Grizzlies per battalion would be required (which appears to be the rationale behind the original plan of 36 per heavy division). Depending on whether one or two Grizzlies are used per breach, in effect every maneuver battalion has the ability to immediately breach obstacles without requiring a significant pause in it's advance. If the

Grizzlies are lost to any cause (battle damage or mechanical failure), then it is assumed that the current breaching methods would be used as a back up. Overall, it appears that 18 Grizzlies per division is a reasonable, cost effective alternative to the original plan of 36 per division.

However, 18 Grizzlies per heavy division still presumes that there is a requirement for all of the maneuver battalions of the division to have the capability to simultaneously breach a complex obstacle barrier. While this requirement may exist for a deliberate breaching operation, it is difficult to imagine a situation where all of the maneuver battalions of a heavy division would require the capability of executing a hasty breaching operation simultaneously.

While the ability to breach "on the fly" is an outstanding advance, it may be more than what is really needed. In Operation DESERT STORM, the US Army 1st Infantry Division (Mech) executed a breach, opening 24 lanes for the division itself, the UK 1st Armored Division and – potentially – for the reserve 1st Cavalry Division to pass through. Notably, the other three US Army heavy divisions and the two armor cavalry regiments had no need to execute breaching operations. Most of the difficulties that these units had with mines were with US SCATMINES, GATOR, and unexploded ordnance encountered in the advance into Iraq. If Grizzly had been available for deployment in DESERT STORM, then the breaching requirement could as easily and more efficiently have been met by attaching 48 Grizzlies (two per lane) to the 1st Division from corps assets. If current plans had been in place, approximately 100 Grizzlies would have been required for the 50 US Army armor battalions, mechanized battalions and armor cavalry squadrons deployed to DESERT STORM (2nd and 3rd ACR, 1st ID (M), 24th ID (M), 1st AD, 3rd AD, 1st CavD). Under the current speculative APO only 18 Grizzlies would have been in place with the 1st Division – 36 if those from the 1st Cavalry Division were attached, leaving the 1st Division 12 Grizzlies short of the ideal requirement. However, since none of the other divisions or armor cavalry regiments were required to breach extensive minefields, potentially as many as 66 Grizzlies (in the 2nd and 3rd ACR, 24th ID (M), 1st AD, and 3rd AD) might never have been used. This experience appears to justify the concept of an austere deployment of Grizzly at the division-level, with a robust backup at the corps-level.

The US Army must also accept that the threat of conventional conflicts has receded. However, the Army still is required to intervene in small-scale contingencies and operations other than war. Grizzly is an ideal vehicle to use in these operations, where mines are often the weapons of choice of the opposing force. As was found in Bosnia, mine clearing – even when there is no conventional resistance to operations, can be a hazardous undertaking. In an operation such as RESTORE HOPE in Somalia, where the majority of casualties were incurred from mines, the deployment of Grizzly would have at least reduced the number. The ability of the Grizzly to minimize casualties makes it extremely useful for mine breaching and mine clearing work in unconventional small-scale contingency operations, where friendly casualties are always a politically sensitive matter. However, rarely will an entire division be deployed for such operations, again calling into question the need for 18 per division?

It appears that a more economical solution would be to procure six Grizzlies per heavy division – giving the division the ability to execute hasty breaching operations by three battalions simultaneously – while assigning a like number to corps engineer assets. With additional vehicles held in reserve and in training units, it could be practical to field Grizzly in a cost-effective manner with a total of fewer than 80 vehicles. Unit cost estimates for Grizzly vary from $6,500,000 to $8,900,000 (the later figure apparently incorporates various final R&D, simulator construction, spare parts and base improvement costs that total about $125,000,000 into the unit cost). It appears that the capabilities of the Grizzly could be restored to the Army by a purchase of 80 vehicles with a total cost of about $700,000,000.[5]

While a reduced number of Grizzlies may not be an ideal solution to the budgetary problem, it may well be a cost-effective trade-off. As is, the US Army and the US Marine Corps may – at worst – be left without Grizzly and may – at best – be forced to accept a very limited number of Grizzly and a delayed delivery schedule. If the worst option remains in effect, then the Army and Marines must rely entirely on existing breaching methods and should concentrate on utilizing their limited budget to improve defects in existing breaching systems. If a limited purchase of Grizzly is authorized, then the most efficient use must be made of the limited numbers procured.

Finally, a contradiction remains to be examined. Currently, the US Army is institutionally opposed to an international antipersonnel mine ban. Since, US Army doctrine is offensive and maneuver orientated, the more logical position for the Army to hold would be to support the antipersonnel mine ban while continuing to develop effective obstacle breaching equipment. This would be consistent with Army doctrine and would maximize US combat power.

[5] Canceling the Wolverine AVLB will increase the cost of the M1A2 Systems Enhancement Package by $450,000 per tank due to loss of shared costs operating the Lima Tank Plant.

GRAPHICS

1. Picture of Grizzly
2. Maps of Omaha and Utah Beaches
3. Maps of Persian Gulf Operations