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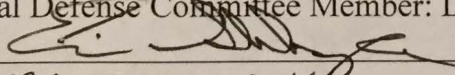
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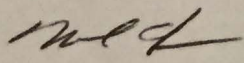
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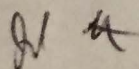
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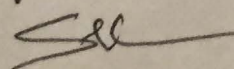
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Executive Summary

Title: Capabilities and Capacities of the Amphibious Force to Counter Mines and Obstacles

Author: Major Brandon Lokey, United States Marine Corps

Thesis: The United States Navy and Marine Corps must determine amphibious breach service requirements for the surf zone in order to develop a capability that will fully support expeditionary warfare's ship to objective maneuver intent.

Discussion: Despite advances in Navy-Marine Corps war fighting concepts and the amphibious enablers, a serious deficiency exists within the amphibious task force and mine counter measure forces. Without a defeat capability within the surf zone, that allows for cleared lanes or zones to the beach, the full intent of operational maneuver from the sea and ship to objective maneuver cannot be implemented, which may translate to an inability to conduct amphibious operations. A compromise of the forcible entry operation due to a disabled craft in the surf zone will have serious consequences to joint force capabilities. In addition, decades of over reliance on clear lanes through the surf zone may no longer be feasible due to the increasing anti-access/area denial environment. Complicating the growing anti-access/area denial threat is the proliferation of such weapons in highly populated littorals where both developed and less developed states seek asymmetrical advantages through the use of naval mines and/or underwater improvised explosive devices to limit the United States ability to project power ashore. It is for these reasons there is a need to develop an in-stride reliable and redundant surf zone obstacle/explosive hazard detection and neutralization or breach capability.

Conclusion: Due to limited amphibious breaching capabilities of the surf zone the US Navy and Marine Corps require a capability to conduct in-stride breaching of the surf zone in accordance with expeditionary maneuver warfare doctrine. The amphibious breaching capability must be capable of breaching obstacles in the surf zone without a break in momentum. In addition, the joint force must collaborate on this dilemma and consolidate efforts in order to further develop existing mine counter measure capabilities and innovate new technologies.

DISCLAIMER

THE OPINIONS AND CONCLUSIONS EXPRESSED HEREIN ARE THOSE OF THE INDIVIDUAL STUDENT AUTHOR AND DO NOT NECESSARILY REPRESENT THE VIEWS OF EITHER THE MARINE CORPS COMMAND AND STAFF COLLEGE OR ANY OTHER GOVERNMENTAL AGENCY. REFERENCES TO THIS STUDY SHOULD INCLUDE THE FOREGOING STATEMENT.

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Preface

Over the past ten months, many people have contributed to my professional education and development at the Command and Staff College at Marine Corps University. Each of them has contributed in some way to my professional development as a person, as a student, and as an officer in the United States Marine Corps.

First and foremost, I would like to thank my wife, Ashley, for her unwavering love, support, and commitment to our country in this profession. To my four boys, Bryson, Braydon, Bryant, and Colt – you guys are still young and don't fully understand why daddy is gone all the time, but you and your sacrifice is always on my mind. The importance of family to anyone serving their country cannot be overstated, because when one member serves, the whole family unit serves.

Next, I would like to offer my thanks to the staff and faculty of the Command and Staff College and the subject matter experts on this topic. Lieutenant Colonel Gregory Marchlinski, USMC, Operations Officer USMC Engineer School, Mr. Nicholson of the 2015 Naval mine counter mine demonstration, and Captain Joe David, USMC, Explosive Ordnance Disposal Chief Information Officer at Combat Development and Integration have helped me bring this project together. I would especially like to thank my military faculty, Lieutenant Colonel Jarrod Stoutenborough and civilian faculty, Professor Mike Lewis and Dr. Anne Louise Antonoff, CDR David Cho USN, ladies of the leadership communication skill center, and my classmates of conference group six and fourteen.

Finally, I would like to thank Dr. Eric Y. Shibuya for serving as my advisor throughout this project, for without your patience, support, and guidance, this thesis would not have been completed.

Abstract

The intended audience for this paper includes individuals with a working knowledge of the USMC's expeditionary maneuver warfare capstone concept in an opposed littoral environment presented in Expeditionary Force-21 as an integral component of the Navy's Cooperative Strategy-21 Sea Strike concept. As such, all terms are not fully explained, but the problem of in-stride detection and neutralization of explosive hazards in the surf zone in the conduct of amphibious operations will address shortfalls in tactics and equipment.

The research methodology used was a combination of subject matter expert interviews, professional journals, doctrinal publications, and historical documentation research. All concerned with achieving the full intent of operational maneuver from the sea and ship to objective maneuver are encouraged to discuss the content of this paper. The findings provided should raise the level of understanding of the criticality of the current shortfall in surf zone obstacle neutralization and breaching as it affects operational maneuver doctrine.

This amphibious shortfall transcends USMC capabilities, so the intention is to stir debate and begin the process of addressing the problem through multiple communities across numerous military occupation specialties. Recommendations will be provided as the first step in achieving the capability to conduct in-stride neutralization and breaching within the surf zone of littoral penetration zones and points.

“We can ill afford to move 3,000 miles to theater and be stymied by mines and obstacles in the last 3,000 yards.”¹

–Maj Gen Rhodes, USMC (ret), Marine Corps Combat Development Command

Introduction

The 2015 National Security Strategy (NSS) explains why the littorals are of particular concern of the United States. The definition of the littorals are defined as the area of the world, to include any body of land and water, within two hundred miles of the ocean. Littoral regions comprise nearly all major centers of international trade, are within the intersections of all major trade routes, and are one of the few remaining places of untapped energy and mineral resources.² Ninety percent of the world’s goods and two-thirds of its oil are transported by sea.³ Currently, over seventy-five percent of the world’s populations live within one hundred and fifty miles of a coast. Today, most of the world’s largest cities are in the littorals. These populations are growing significantly into what is becoming known as megacities, a population that exceeds ten million. Within the megacities, the alarming number of people living in poverty continues to rise. It is estimated that one in seven people now live in a megacity’s urban slum.⁴ There are currently twenty-nine littoral megacities and by 2030 that number is expected to grow to forty-one.⁵

Given these facts, the potential for crisis around the world’s littorals are expected to increase throughout the twenty-first century. The United States’ strategic concerns include access to geographic littoral areas, particularly in the Pacific, where adversaries are increasingly attempting to deny, prevent, or limit United States access. If the United States is going to maintain a dominant influence in key regions of the world, then its

military must have access to these areas. If deterrence and diplomacy fail in a region, naval forces must be poised for immediate sea-based response to include Forcible Entry Operations (FEOs) against a denied area with the ability of maritime forces to seize advanced bases and enable the flow of follow-on forces.⁶

Navy-Marine Corps war fighting concepts and the advancements of amphibious enablers require twenty-first century reconciliation and strategic alignment to ensure doctrine is fully supported by current and future technologies. Furthermore, this study identifies several deficiencies of the Amphibious Task Force's (ATF) ability to counter mines and obstacles. Adding to this problem, the Joint and Navy-Marine Corps amphibious concepts and doctrine assume air superiority is achieved prior to an amphibious operation. The US's ability to confront serious threats in the twenty-first century will depend on its ability to project combat power ashore in any environment, with or without air superiority. It is for these reasons the Navy-Marine Corps team must develop an in-stride amphibious breach capability and an Explosive Hazard Defeat (EHD), particularly within the Surf Zone (SZ); matching war fighting power projection with current amphibious doctrine and utilization of the sub-sea as maneuver space.

Role of Mines and Obstacles in Amphibious Warfare

Anti-access/area denial (A2/AD) are the means by which adversaries defend against attack from the sea, and include coastal artillery, cruise and ballistic missiles, surface ships, submarines, aircraft, and mines. As United States seeks to expand its reach within the littorals and maintain access to key geographic regions, adversarial A2/AD defenses are also adapting. "With costs measured from a few hundred to several thousand

dollars, they are the weapons of choice for a “poor man’s navy,” providing an excellent return on investment: low cost and high effects.”⁷

The increasingly populated littorals are poised to employ simple unconventional methods that seek anti-access advantages against a conventional amphibious force. This most likely will be achieved through the use of naval mines and/or Underwater Improvised Explosive Devices (UWIEDs) in the SZ areas due to the simplicity of manually emplacing mines in shallow zones by craft or person; however securing mines in the turbulent SZ can present a challenge. These “weapons that wait” are the quintessential asymmetric threat, pitting adversaries’ strengths against US Naval and maritime weaknesses.⁸ According to the current and future threat brief during the 2015 mine warfare improvement program, “there is an overwhelming amount of enemy mine activity, production increases, technology advances, and clandestine deployment methods.”⁹

With exception of more lethal cruise and ballistic missiles as the modern form of coastal artillery, A2/AD threats are not unique to amphibious operations throughout history. In fact, mines and obstacles are the oldest, cheapest, and most prolific threat to naval projection of power in amphibious operations. In 1778, patriot David Bushnell used floating kegs of gunpowder fitted with contact firing mechanisms to attack a British fleet anchored in the Delaware River near Philadelphia.¹⁰ In 1950, off the coast of North Korea, more than 3,000 mines halted the amphibious assault on Wonsan by a 250 United Nations ship amphibious task force.¹¹ In 1991, the US Navy lost command of the Northern Arabian Gulf due to more than 1,300 mines that had been laid by Iraqi forces

that subsequently damaged two Navy warships. US commanders aborted amphibious assault possibilities for fear of more casualties.¹²

These threats have been present since the earliest days of the republic and actions have been developed to counter each of these traditional threats; however, what is new is the proliferation of both state and non-state actors in acquiring mines. More than a million mines of more than three hundred types are estimated in the worldwide inventories, not including US weapons.¹³ More than thirty countries produce mines, and twenty countries export them through the international arms trade.¹⁴ These numbers are for sea mines proper; they do not include UWIEDs that can be fashioned from fifty-five-gallon drums, other containers, and even discarded refrigerators.¹⁵ “Since the end of World War II mines have seriously damaged or sunk almost four times more US Navy ships than all other means of attack combined.”¹⁶ While mines and even UWIEDs might not completely deny naval projection, *Ship-To-Objective-Maneuver (STOM)* forcible entry momentum cannot afford a stoppage in the SZ due to a lack of capability to detect and breach explosive hazards.

Additionally, mines are easy to store, hide, and can be clandestinely laid from virtually any platform. The SZ does present challenges in the laying of obstacle belts of mines due to the same turbulence that is characteristic of the SZ. Keeping mines in place in the SZ requires additional measures to secure the mines to the bottom and more sophisticated firing mechanisms capable of withstanding the eroding effects of the SZ to distinguish between rough surf and a landing craft. While difficult to employ in rough surf, mines will continue as the last line of defense of ideal landing sites. Due to greater A2/AD missile proliferation, greater areas of coastline are denied, which results in less

options in choosing a landing site. Adversary coastal defense “gap” areas will be littered with the quickest, least expensive, and most expedient obstacles and/or UWIEDs. The less ideal sites for an amphibious landing may become more lucrative when adhering to the EMW doctrine due to the perceived avoidance of surfaces and exploitation of gaps in coastal defenses. In these potential landing sites, if the SZ is the only mined area and the US lacks effective detection and in-stride breach capabilities of the SZ, the momentum of the FEO could be jeopardized.

Amphibious Doctrine

The United States Marine Corps’ (USMC) blueprint to meet these coming challenges is detailed in *Expeditionary Force 21 (EF-21)*. *EF-21* states, “the Marine Expeditionary Brigade (MEB), as part of an integrated naval force, must be capable of maneuvering with reduced signature from greater distance and conducting dispersed operations.”¹⁷ Due to the growing A2/AD threats, *EF-21* espouses that the Marine Corps must be prepared to conduct full-scale amphibious operations in non-permissive environments. *EF-21* also states, “landing site superiority must be established during amphibious operations requiring control of seaward approaches, landing areas, and the ability to inhibit threat actions.”¹⁸ *EF-21* further directs the force to “identify, classify, bypass, and when necessary breach obstacles within the littorals” and “overcome ground obstacles (explosive and non-explosive) from the seaward approach when they cannot be by-passed during an assault.”¹⁹ In addition, *EF-21* directs the force to “detect and neutralize explosive hazards, including mines, improvised explosive devices, unexploded ordnance, and explosive remnants of war”²⁰ to enable seaward approach in A2/AD environments to assure littoral access, secure entry points, and protect assets.²¹ Due to the

requirement to establish landing site superiority, the amphibious force must develop an organic in-stride breaching capability of the SZ. The 2015 Commandant's Planning Guidance (CPG) shifts focus in 2017 and 2018 toward how the Service will fight in an increasingly robust A2/AD environment in the 2025 timeframe.²² While the CPG states with regard to A2/AD capabilities that "our experimentation will be concentrated on developing and fielding highly advanced, indirect, or disruptive concepts and capabilities," that exact capability has not yet been defined.²³

Operational Maneuver From the Sea, published in 1994, addressed the application of the tenets of maneuver warfare to amphibious operations, allowing rapid maneuver of landing forces from amphibious ships directly to objectives ashore without a break in momentum or establishing an initial beachhead ashore.²⁴ *STOM*, released in July 1997, continued to refine the discussion and requirements to meet the increasing focus on the littorals.²⁵

Within *EF-21*, *STOM* is the tactical and operational extension of Expeditionary Maneuver Warfare (EMW), which allows surface and vertical assault units to move from the sea base to their objectives. Due to A2/AD proliferation, these concepts hinge on certain technological innovations that make the concept a reality, such as the MV-22 Osprey, the new Amphibious Assault Vehicle (AAV), the improved Landing Craft Air-Cushion (LCAC), and the future version of the heavy-lift helicopter CH-53E. While vertical assault forces will be capable of ranging out to 110 miles from the sea, the requirement for surface forces traveling twenty-five miles from over the horizon and continuing inland remains key to maintaining today's naval mission of regional contingency operations with the capability to conduct FEO.

In most historical amphibious assaults, the objective is an airfield in order to gain air superiority, which entailed assaulting and taking a beachhead, then making movement to the final objective only after sufficient combat power and logistics was built up ashore. This type of amphibious assault resulted in high casualties due to long operational pauses while building combat power ashore. In fact, the average operational pause for the twenty-two major amphibious assaults of World War II was eighteen days.²⁶ Today, the *STOM* doctrine assumes air superiority is achieved prior to the assault. Under *STOM*, during the entire assault, the amphibious fleet will remain over the horizon, where it will be less vulnerable to current anti-ship missile and mine threats.²⁷

Despite the advances in the Navy-Marine Corps war fighting concepts and the amphibious enablers, a serious deficiency exists within the ATF and Mine Counter Measures (MCM) forces in conducting amphibious operations in a mine environment. Without a MCM capability to detect, mark, neutralize, breach, or proof the SZ, allowing for clear lanes to the beach, the full intent of *STOM* cannot be implemented. Assumptions about unimpeded access and air superiority in amphibious operations, specifically through the surf zone, is no longer feasible.

In order for the ship to objective maneuver doctrine to work, the sea must remain the essential maneuver space for the landing force from over-the-horizon to the shore, while not restricting movement in route, allowing commanders to “specifically find or create exploitable gaps” to the Littoral Penetration Points (LPP).²⁸ The SZ not only requires a in-stride breach capability, it will first require a detection and marking capability that does not compromise the location of the landing, or assume air superiority. “Given the need to maintain the element of surprise and momentum when assault forces

are moving from the line of departure to the specified LPPs, it is imperative to prevent an operational pause in the execution of an assault.”²⁹

The landing force must be able to locate, identify, neutralize, breach and/or avoid natural and manmade obstacles. Although the shift has changed from seizing a beachhead as the objective to crossing a LPP that best supports the mission of each landing element commander, the requirement to reach the beach still exists (figure 1). In fact, the requirement for a SZ breaching capability is greater today than ever before due to the *STOM* doctrine’s mandate to cross the LPPs without a break in momentum and A2/AD proliferation. A break in the amphibious assault momentum not only depends on overcoming hazards in the SZ, but a clear understanding of the Naval and Marine Corps roles and responsibilities in MCM in order to have a smooth transfer of authority from sea based to land based operations.



Figure 1. Source: Headquarters United States Marine Corps, *Expeditionary Force – 21*, March 4, 2014, 22.

Mine Counter Measure Doctrine

Joint Publication (JP) 3-02 is the main document that delineates MCM responsibilities during an amphibious operation. The US Navy is responsible for MCM missions in Deep Water (DW) (> 200'), Shallow Water (SW) (40' - 200'), Very Shallow Water (VSW) (10' - 40'), and the Surf Zone (SZ) (< 10'), which includes the High Water Mark (HWM) (figure 2).³⁰ The US Marine Corps is responsible for MCM missions from the HWM to the Beach Zone (BZ) and the Beach Exit Zone (BEZ).³¹ The VSW and the SZ continue to challenge the Navy's MCM capabilities due to the breaking and plunging waves that make this shallow area "noisy and nearly opaque to both acoustics and optics."³²

The Navy, usually the Commander Amphibious Task Force (CATF), has responsibility from the sea base to the beach exits and the Marine Corps, usually the Commander Landing Force (CLF), has it from the beach to the objective. This command relationship and transfer of authority is crucial to understanding the MCM responsibilities, capabilities, efforts, and missions of both services.

Doctrinally referred as the "line of demarcation", this operational seam is the point in the amphibious operation where the operational authority transfers from the CATF to the CLF. A line of demarcation is a line defining the boundary of a buffer zone. Per JP 3-02, in the case of an amphibious operation, this could be any place mutually agreed upon by the CATF and the CLF. At first, JP 3-02 states the CLF will have MCM responsibilities at the point of demarcation, but the assumption could be the line is at the

SZ or on the beach.³³ In this case, the transfer of authority for mines in the SZ could shift to the USMC. Nothing mandates that the point of demarcation must be on the beach, but the JP clearly states that this is the point where the CLF assumes MCM responsibilities.³⁴ In addition, JP 3-02 does not specifically address UWIEDs or other explosive hazards and fails to mention mine warfare in the SZ.³⁵ The SZ is also the area that allows for less expensive mines to have greater anti-access effects. As depicted in figure 2 below, the SZ and VSW require human forces or other mammals (dolphins/sea lions) to do the exploration and reconnaissance due to the violent nature of this region.

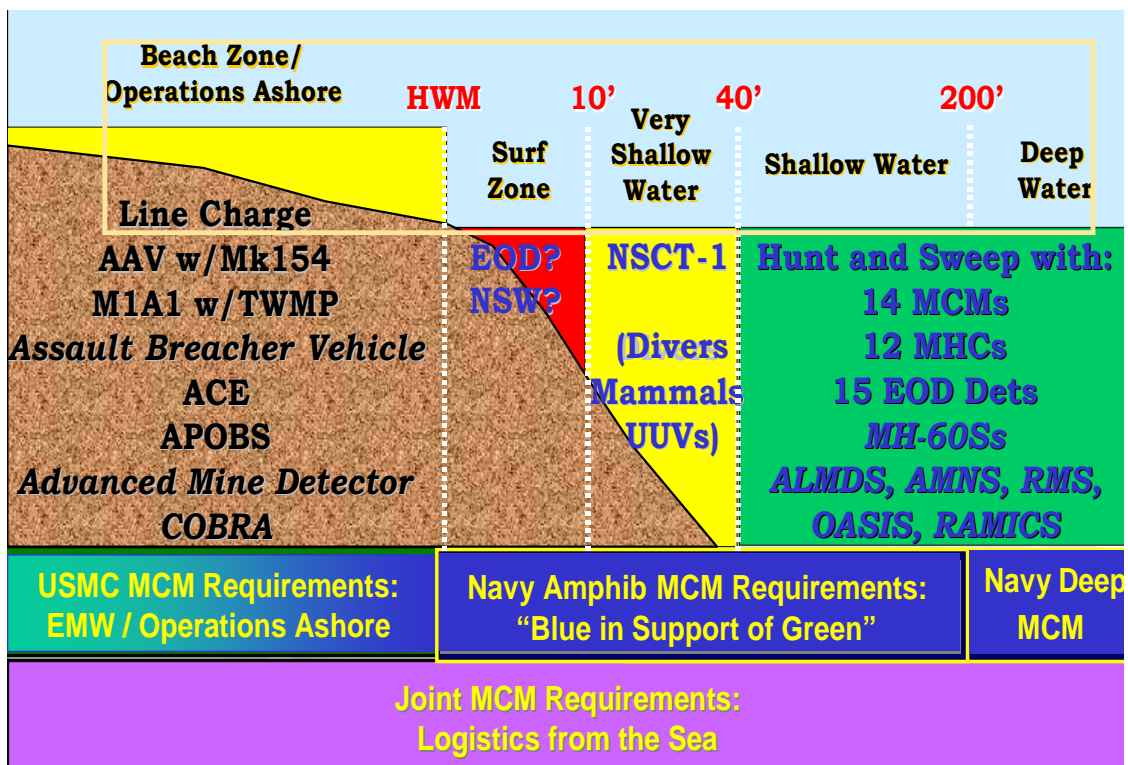


Figure 2. Source: Marine Corps Plans and Policies Division. Naval MCM Requirements and Capabilities. Power Point Slide, April 2002

Key to *STOM* are clear and marked lanes within littoral penetration points, created to thrust Marine Air Ground Task Force (MAGTF) forces ashore at multiple locations. The penetration points are determined by the tactical situation and landing site criteria. Each LPP has lanes marked by naval beach master personnel that guide assault

craft ingress routes. In a FEO, the initial waves will be the USMC's AAV. Due to a greater A2/AD threat, *STOM* allows for the concentration of forces ashore via multiple penetration points, which allows the amphibious force to bypass the enemy's obstacle belts (figure 3). *STOM* executed through numerous LPPs creates multiple dilemmas for the enemy commander to respond, which disrupts cohesiveness and can diminish his will. In order to defeat the A2/AD efforts and adhere to this concept, the capability to clear lanes through the VSW and into the SZ must allow for clandestine neutralization or in-stride breaching without disrupting the momentum of the surface assault.³⁶

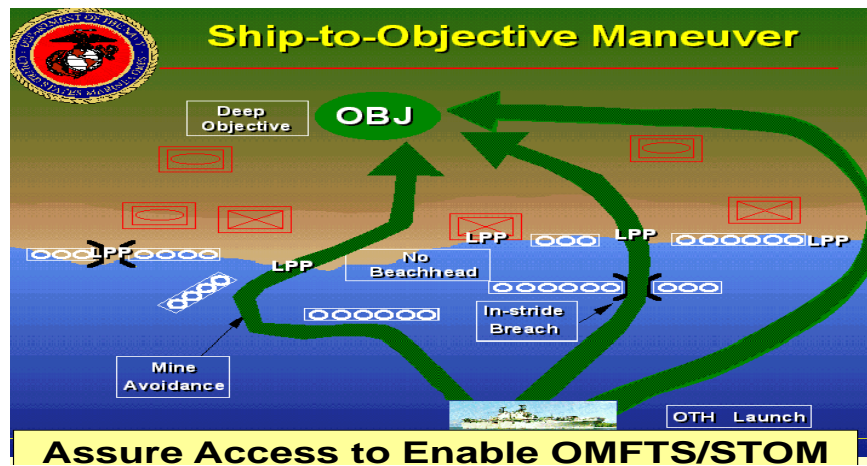


Figure 3. Source: Office of Naval Research, Assault Breaching Technologies Update, Power Point Slide, April 2011

Mine Counter Measure Capabilities

The US Navy has improved “capabilities in exploratory and reconnaissance operations in the VSW, SW, and DW regions following the lessons learned from the Gulf War”³⁷ but today identifies its MCM capabilities in the SZ as the most deficient. In addition to the MCM mission gaps, Captain Joe David, USMC, EOD Technician stated in his most recent amphibious capability study trip report:

The Navy is the only service that is currently manned, trained, and equipped to provide Explosive Ordnance Disposal (EOD) capabilities underwater; however,

Navy EOD does not provide underwater EOD capabilities in the SZ, does not conduct night diving operations, and does not dive in a non-permissive environment, all of which are likely conditions of an amphibious assault.³⁸

Although mines can be constructed in virtually any configuration, there are four primary types: “bottom (or ground) mines, buoyant moored mines, floating (or drifting) mines, and limpet mines” (see figure 4)³⁹. The USN’s separate and distinct missions in MCM are: *search, locate, classify, identify, and neutralize*. Naval MCM forces possess the ability to conduct four of the five required skills of any mine countermeasures operation.⁴⁰

MINE THREAT SPECTRUM

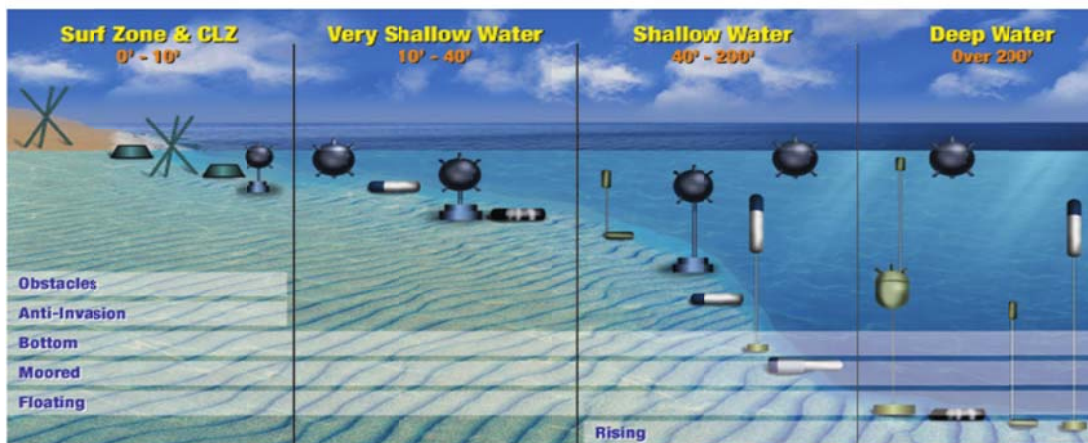


Figure 4. Source: Naval War College Review, Taking Mines Seriously, Spring 2012, Vol. 65, No. 2, 36.

“The ability to *search* an area, *locate* mine-like objects and obstacles (natural and man-made), *classify* the objects as mines/obstacles or non-mines, and *identify* the specific threat exists as naval capabilities in the VSW, SW, and DW regions today.”⁴¹ The fifth skill, *neutralizing* mines/obstacles in these regions, is not currently a capability. In addition, the SZ region is not a MCM effort area in which the “*search, locate, classify, identify, and neutralize*” sequence applies. The SZ is currently breached by brute force,

without the same precursor MCM reconnaissance effort to find a gap in enemy defenses. The DW, SW, and VSW MCM planning does aid in the SZ breach assuming clear lanes through the mined areas to the SZ are appropriately marked.⁴²

The final critical enabler of amphibious force MCM operations is the USN's ability to mark clear lanes of ingress for the amphibious craft. Once the LPPs are selected, obstacles are detected, and MCM clearing operations commence, the MCM effort must be complimented by effective lane marking for safe passage of the amphibious craft. Given the complexity of marking and guiding landing craft through lanes from ship to shore and the cancellation of the USMC's Expeditionary Fighting Vehicle (EFV) in 2011, the ability of the USN to provide the USMC's assault force with navigable lanes through the LPPs remains difficult. The EFV's navigation technology was designed to be compatible with the USN lane marking system and would have provided the EFV operator a digital display of clearly marked lanes through the surf zone through the beach exits. Without the EFV, the landing force will continue to follow designated ingress and egress paths to the beach as it has in the past. Neutralization of mines could be delayed until after the amphibious assault if sufficiently clear routes to the beach are found prior to the assault, but again the increased risk of a break in momentum due to immobilized landing craft and casualties in the surf zone can stifle the entire operation.

Although the USMC and USN have distinct MCM capabilities, the Navy is continuously developing MCM capabilities to improve their own operations, aside from Marine Corps operations. The amphibious force's ability to conduct amphibious breaching lies solely with the Navy's capabilities and capacities to employ detection and

location systems, neutralization technologies, and explosive breach capabilities, however none of the systems is designed to complement each other.

MCM Detection

USMC Force Reconnaissance, Marine Special Operations Forces, and USN Sea-Air-Land (SEALs) are missioned with the capability of conducting reconnaissance and hydrographic surveys of LPPs.⁴³ LPPs can be 500 meters apart and LPZs can be five kilometers wide and separated by three kilometers, equating to over four-and-a-half miles of shoreline, a daunting task even for the combined efforts of SEALs, Marine Force Reconnaissance, and Marine special operations teams.⁴⁴ While highly effective for choosing a landing site, hydrographic surveys do not include the SZ, nor do they possess EOD/EHD capabilities. The hydrographic survey includes the SW and the VSW zones only. Once a landing site is chosen, the commander must assume the risk of mined SZ's and the effects on the amphibious assault through the LLP's. Due to the violent conditions of the SZ and the risk to personnel, placing combat divers in the SZ is not practiced, nor is it a risk the USMC or USN is willing to accept, at this time. It is not feasible to conduct several miles of SZ clearance with the limited USMC and SEAL teams, as the clearance operation would require EOD support, a limited asset to any operation. In addition, the idea of sending clearance teams into the SZ is not consistent with the *STOM* doctrine. Unless precisely coordinated with the landing craft, as soon as the teams began systematically detonating the charges to clear the lanes, the location of the landing site would be compromised.

In addition, the capacity of manpower and forces to conduct the MCM mission in the scope and size required for an amphibious force to counter this increased threat, is

lacking.⁴⁵ In recent years, the US Navy has been relying heavily on coalition and partner nations to increase and enhance mine warfare, including MCM, in numerous theaters.⁴⁶ The fact is (with exception of the United Kingdom, France, and Australia's amphibious landing craft) none of the US coalition partners have amphibious breaching or assault capability beyond what the US currently has. In addition to relying on coalition partners (mainly for additional manpower), the Navy's current detection and neutralization capacity of the SZ relies solely on MCM materials and technology. Most of the Navy's recent studies do not place much emphasis on manual capabilities for future solutions such as combat divers, EOD technicians, or combat engineers. Today's technology is not yet mature enough for fielding the current solution.

Instead, the Navy's MCM efforts focus on removing the human from the water. EOD personnel and VSW MCM Detachment utilizes mammal systems. These detachments support covert exploration and reconnaissance of the VSW and seaward approaches in support of operations such as amphibious assault. While effective in other zones, the Marine Mammal Systems (MMS) such as dolphins, sea lions and beluga whales for mine detection and neutralization in the VSW cannot be utilized for the SZ due to the shallow depths being unfeasible for the dolphins and whales, and the crashing waves drastically reducing visibility for sea lion detection. The Navy is working on systems to replace their use, but the Navy's EOD Mobile Unit One VSW Platoon (mammals) is intended for deactivation next year.⁴⁷

The most current technology in MCM is deployed via the Unmanned Underwater Vehicles (UUVs) (figure 5). The design of the torpedo shaped UUVs have performed well in the DW, SW, and VSW regions; however, under violent surf conditions most

UUVs have been overtaken in the SZ. UUVs can prepare the assault area and ensure the safest routes to the LPPs are established. The UUVs are preprogrammed to follow pre-designated routes through the mined areas to the SZ.”⁴⁸ The technology of the UUV can be matched to a platform capable of performing the lead-through concept. This platform is a vehicle that can survive the turbulence of the SZ, detect, and map the hazards for precise munition targeting, or neutralizing the mines itself with a chemical dart. One such category of vehicles being developed today, to deal with the violent actions of the SZ is known as “bottom crawlers.”⁴⁹

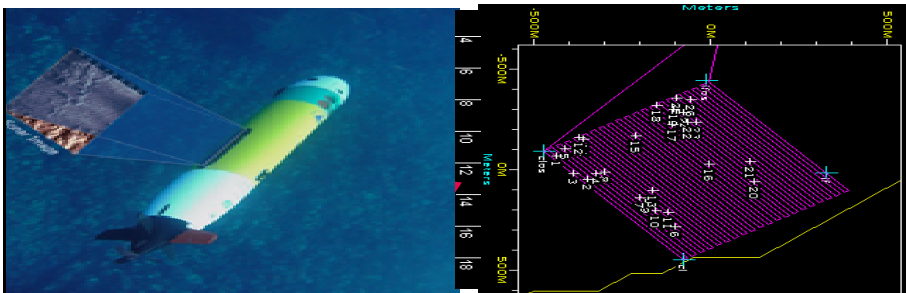


Figure 5. Source: US Navy EOD, Enabling Access, Mine Warfare Meeting, Power Point Slide, May 2005

The “bottom crawlers” or Autonomous Underwater Vehicles (AUVs) have proven to perform well in detection of hazards in the SZ with a sandy bottom, however, in silt or mud, the AUVs tend to get stuck (figure 6). In addition, the AUVs would be required to be armed with the capability to neutralize hazards, which could be a possible upgrade to the current AUV testing. The Navy seeks to “reduce the time between detecting a threat and neutralizing the mine while keeping the ship, sailor or mammal out of the minefield.”⁵⁰ AUVs can contribute significantly to the clandestine phase of an amphibious operation.⁵¹ In addition to the reduced risk to personnel, AUVs can be deployed or recovered from any vessel, stored in prepositioned packages, operate in any weather, are less likely to become fouled by debris, and testing has shown that the

platforms are conducive to good detection capability with possible upgrades available for mine neutralization.⁵²



Figure 6. Source: US Navy EOD, Enabling Access, Mine Warfare Meeting, Power Point Slide, May 2005

Advanced technology and development in the surveillance and detection of aerial reconnaissance of the SZ is accomplished with the Rapid Overt Airborne Reconnaissance (ROAR) true three-dimensional Light Detection and Ranging [(LIDAR) (see figure 7)]. The ROAR can be deployed at any time and is operated from a helicopter or Unmanned Aerial Vehicle (UAV) without placing any other persons or equipment in the water. The ROAR system can cover the VSW and SZ at a depth of forty feet and minimum depth of four inches of water.⁵³ In addition to the VSW and SZ regions, ROAR can map the Beach Zone (BZ). The upgraded version of ROAR is a USN Ch-60 helicopter that deploys a laser mine detection system known as the Coastal Battlefield Reconnaissance and Analysis system (COBRA). The USMC is currently considering the COBRA to add to its MCM capabilities. Also, the COBRA is only a viable option if air superiority is achieved, which will become increasingly difficult due to greater A2/AD capabilities. While ROAR may be the all-inclusive detection system, detection alone will not solve the in-stride breach capability required for the full intent of ship to objective maneuver, but could aid in the neutralization through other means.

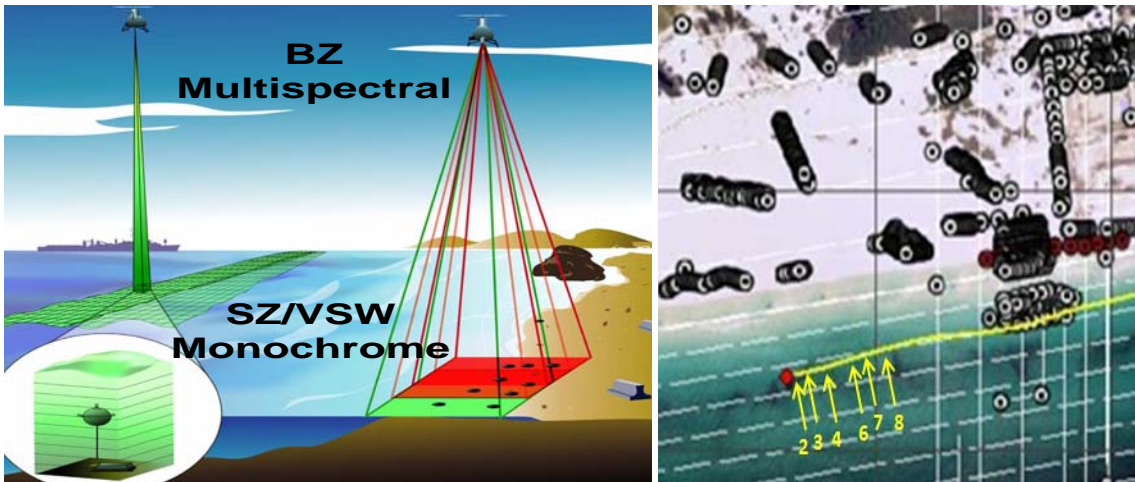


Figure 7. Source: Office of Naval Research, Assault Breaching Technologies Update, Power Point Slide, April 2011

MCM Neutralization

There are multiple delivery platforms for the dispensing of chemical darts, but regardless of how they are delivered, the chemical dart is highly effective in neutralizing a large portion of the mines in the SZ [90 percent hits within ninety foot diameter (see figure 8)].⁵⁴ Chemical darts deployed by advanced munitions can reach the LPPs very quickly and could be conducted in-stride. The darts are designed to penetrate various combinations of air, water, and sand, as well as the material used to construct the mine (plastic, metal).⁵⁵ As the dart punches through the case of the mine, the chemical reacts with the mine explosive causing an exothermic reaction resulting in the mine's destruction. The chemical dart removes the risk of placing Sailors and Marines in the water, can be conducted in-stride to support *STOM*, offers standoff precision neutralization, and rapid follow-on SZ clearance. The darts provide a breach capability, but also require air superiority. Unfortunately, the darts create widespread Unexploded Ordnance (UXO) issues associated with thousand of tiny darts littering the landing sites. The Navy also has the capability to neutralize mines from the air by means of a

supercavitating projectile fired at mines from a MH-60S helicopter Gatling gun. Known as the Rapid Airborne Mine Clearance System (RAMICS), the gun's projectile can neutralize surface or near-surface mines. Again, unfortunately, this system requires air superiority and visual targeting from the air. Due to the murky and churning conditions of the SZ, the line of sight RAMICS has not fulfilled the SZ MCM goals.

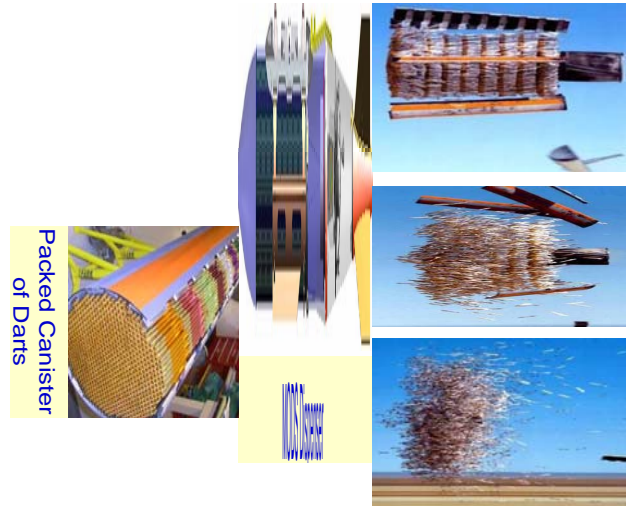


Figure 8. Source: Office of Naval Research, Status & Issues for Assault Breaching System Technologies, Power Point Slide, May 2007

MCM Explosive Breach

The USN's Landing-Craft-Air-Cushion (LCAC) (the amphibious force's primary ship to shore connector) has been outfitted with a C-4 line charge, known as the Shallow Water Assault Breaching System (SABRE) and is similar to the USMC's MK-154 Linear Mine Clearing System (LMC). In addition to the LCAC's SABRE, it has been outfitted with an explosive net device, known as the Distributed Explosive Technology (DET), to neutralize mines in the SZ. The LMC will clear obstacles in the ten-foot to three-foot water depth range with limited success. The DET is designed to clear the remainder in the three-foot region of the surf. While effective on the ground of clearing a 100 m x 16 m lane, the LMC is not particularly effective at the water's edge. The USMC utilizes the

AAV with the MK-154 LMC kit (figure 9 and 10)⁵⁶ to breach beachhead defenses in the first waves of the assault, beginning at the HWM to the objective; however, this capability is not effective in conducting amphibious breaching of the SZ. The USMC AAV is the primary surface troop transport craft during an amphibious operation and is deployed in waves guided by marked lanes to the LPPs. The AAV's draft depth is approximately eight feet (figure 9).⁵⁷ It transitions from swim mode to crawl mode, in the operational seam of the SZ. As the AAV's tracks make contact with the bottom onto the beach and out of the water, it is extremely susceptible to mines and UWIEDs placed in the SZ. USMC engineers also utilize the Advanced Breaching Vehicle (ABV), built around an M1 Abrams, to clear lanes on the beach once delivered by Landing Craft-Utility or LCACs, however this is not an amphibious in-stride capability.

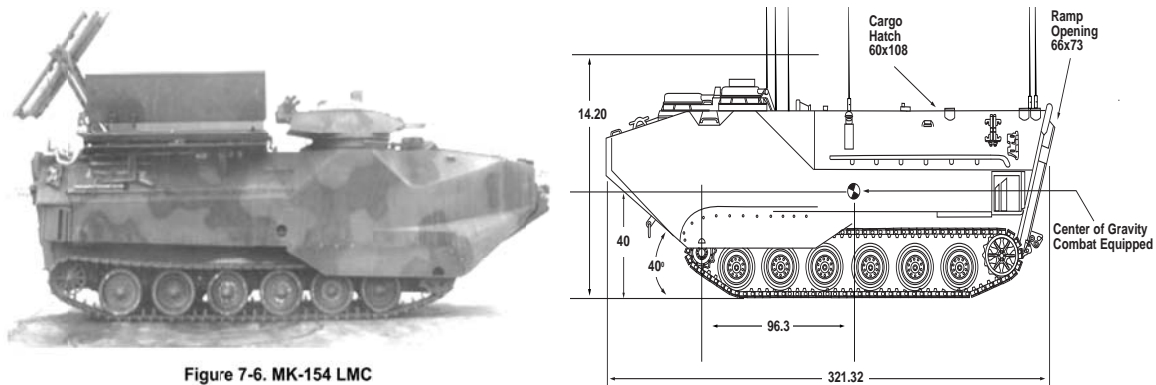


Figure 7-6. MK-154 LMC

Figure 9. Source: MCWP 3-13 w/chg 1, Employment of Amphibious Assault Vehicles (AAVs), Fig 7-6 and appendix A, February 17, 2005



Figure 10. Source: MSgt Jonathan Damren, USMC, Requirements Analysts, Capabilities Branch, The Operational Engineer, Marine Corps Engineer School, Winter 2015/2016 Newsletter, Volume 8, Issue 3

While capable of SZ breaching, the SABRE and DET are not “in-stride” capable, nor are they compatible with *STOM* concept of operations for the order of amphibious craft sequencing during STS movement. Utilizing SABRE or DET would require unarmored LCACs to approach a hostile beach before armored craft could arrive. Next, the LCU, a slow displacement craft, would be required to deliver a mechanical breacher like the ABV to the beach. LCACs cannot deliver a mechanical breacher initially because they cannot cross the presumably mined SZ, nor off-load in the SZ. In addition, neither the SABRE nor the DET are capable of proofing the littoral penetration point lanes or reducing large obstacles in the SZ.⁵⁸ Lastly, if LCACs and LCUs are utilized for forcible entry operations it will be very difficult to generate the tempo needed for *STOM*-type tactics.

The current and most effective capability for breaching obstacles, in-stride, of the surf zone and very shallow water, is the United States Air Forces (USAF) Joint Direct Attack Munition - Joint Assault Breaching System (JDAM-JABS).⁵⁹ JABS, deploying the 2,000 lbs Mk84 JDAM, is the amphibious breach weapons system of choice, but airspace

dominance is required. JABS is a precision air delivered sub-munition bomb designed to breach a landing lane by destroying or neutralizing SZ mines. The issues with the JABS are many. If the JABS does not detonate the amphibious force has a significant Un-Exploded Ordnance (UXO) hazard that poses a significant risk during the assault or later due to proliferation (IED material). The UXO rate for the JABS includes a standard 10% failure rate for planning factors. The JABS detonation is so powerful the result is a high probability of cratering the lanes as to make them impassable. Lastly, JABS saturate the LPAs with fragmentation, degrading many current and future explosive defeat capabilities, such as the COBRA. Utilization of the JABS depends on air-superiority and very close coordination with the air space control command relationships in a joint operation. While reliance on coalition partners, technology, or ordnance to clear the SZ appears good in theory, in practicality the SZ cannot be proofed on technology alone, rather it will need to be combined with a mechanical solution.⁶⁰

The Navy's airborne MCM helicopters and underwater MCM explosive ordnance disposal divers⁶¹ are trained and equipped for the MCM permissive environment only. However, given the threat scenario, water depth and proximity to the shoreline, and airspace dominance, limited MCM reconnaissance can be conducted by these assets in advance of an amphibious assault without compromising the LPAs or LPPs,⁶² but the SZ detection and neutralization dilemma still exists.

Recommendations

MCM is a problem for any service that participates in amphibious operations. The CATF and the CLF devise where their operational seam (the line of demarcation) will take place and how the transition will be executed. This transitional seam could be

anywhere in the near the shore. The EMW and *STOM* concepts are designed to defeat the increasing A2/AD threats, with multiple insertion points extended over a larger area with no break in momentum to the objective. In order to defeat A2/AD threats and based off current doctrine interpretations, the Marine Corps must have an in-stride breach capability in the water and build amphibious explosive hazard defeat capability by training the USMC EOD community as a mission essential task.

Recommendation One

First, service ownership will need to be defined and doctrinal publications will need to clearly define that ownership and the responsibilities. Once this is accomplished, the proper sourcing solution can be pursued through a single acquisition office with the sponsoring resource manager in the owning service. This would ensure both accountability and consistency in addressing the current deficiency. In addition, one community, military occupational specialty, or MCM system may not solve the problem but the USMC can establish an amphibious working group to address gaps, recommend solutions, and establish a way forward to further develop existing organic Marine Corps capabilities, starting from the VSW zone.⁶³

Recommendation Two

Secondly, the detection, neutralizing, and explosive breaching capabilities discussed, if used together, could ensure clear access to LPPs, however none of the remote or manual systems are designed to compliment each other. While technology and strategies in war will evolve, what will not change is the nature of war. War will remain, as it has since the beginning of man, inherently – human. Since WWII, the US has enjoyed relative peace in its unipolar world, however the increasingly multipolar world of

the twenty-first century is challenging the status quo. Against an existential threat, over reliance on unmanned systems and the assumption of air superiority compromise the US's amphibious capability. The existential threats of today, much like WWII, will require placing humans in the water to neutralize hazards. Only manual capabilities (such as USMC Reconnaissance, SEALs, EOD, or Combat Engineers), if used together, can complement unmanned remote systems and offer a near term solution; however, each manual specialty would require a new set of skills in order to be properly trained (i.e. underwater demolition and/or swim qualifications).

In addition, if manned and unmanned systems are used together, each MCM zone could be mapped early for the landing force by remote and manual systems (ROAR, UUVs, humans) virtually undetected. Not assuming air superiority is achieved, traditional MCM, such as the Avenger Class of MCM Naval ships, employ a concept known as lead-through. The concept includes a "minesweeper/mine hunter leading a larger warship in and out of mined waters to an area of free maneuver."⁶⁴ Applying this traditional MCM concept to the technology of the UUV and combining the maneuverability of the AUVs in the SZ, the desired SZ detection and neutralization capability is possible. This conceptual platform would provide the versatility of detection and mapping technology of the UUV, producing a single redundant clandestine capability of detection and marking, via global positioning system, of the LPP SZs. By utilizing UUV mapping technology, the AUVs would have the ability to search, detect, and map a potential assault lane all the way up to the beach. In addition, AUVs could be transported through deep waters via a UUV that carries numerous AUVs to the SZ. For example, a team of UUVs could do the deep water lead-through up to the SZ, set down on the bottom of the

sea, and then open to deploy ten to twenty-five expendable AUVs with sensors that will provide real-time mapping data of the desired lanes.⁶⁵ The AUV combined with hydrographic surveys of manual teams could then prep a landing site for assault in a relatively short period of time.

Alternatively, once the mapping data is collected and neutralization is completed, via AUV armed chemical darts, the AUVs assemble back into the UUV and it swims undetected back to the ship over the horizon. The AUV could supply the joint force with the data required to precisely breach the LLPs with the JABS or carry mine chemical darts to neutralize the hazard, making in-stride breaching of the SZ a reality. Most importantly, this concept would support the *STOM* tactics, thus preserving the element of surprise and allowing for last minute programming or in-stride breaching as the planning of the amphibious routes are finalized. This could buy the amphibious task force time to build the plan and provide the lane marking required of ensuring safe passage through the lanes and allowing for the seamless maneuver to the objective.

Recommendation Three

Lastly, and most importantly, the development and acquisition of an USMC or USN amphibious mechanical in-stride breach capability (particularly for the first assault wave) is required. Current manned and unmanned MCM systems are not designed to work together and each system has its own limitations in the non-permissive environment. Detection and reduction of obstacles in the SZ can be improved by combining existing concepts with technologies, increasing coordination of the joint amphibious force, and manual applications. Throughout history, technological advances in warfare are effective until countered by the opponent. Today, A2/AD threats counter

the US's ability to project power ashore by building defenses that counter the strengths of our Naval and amphibious forces, turning our projection capabilities into weaknesses. Today, the USMC's AAV in a FEO appears weak against a conventional adversary's A2/AD defenses. If air superiority is not obtained and the amphibious force is conducting FEO in order to seize an airfield to achieve air superiority, the AAV is the first wave vehicle. The USMC AAV is a metal box with Marines inside, the only of its kind within the US military, missioned with conducting amphibious assaults in a non-permissive FEO. Without air superiority, adversarial A2/AD defenses can easily target the AAV's weaknesses to include: a lack of tempo, lack of fighting power, audibly loud, highly visible, and lack of MCM capability until ashore. The AAV moves at eight miles per hour in swim mode, resulting in dangerous transit times. Splashing from amphibious ships from fifteen miles out at sea and traveling at eight miles per hour equals a swim transit time of one hour-fifty two minutes to shore, or from seven miles is fifty-three minutes. The losses in a future FEO in the A2/AD operating environment without air superiority are surely to be high and may not be possible. The USMC's adherence to its war fighting doctrine when faced with possible existential threats of the twenty-first century will require exploiting surprise, initiative, shock, speed, boldness, and maintaining momentum. Today's FEO with current capabilities and capacities requires air superiority. Without air superiority and due to A2/AD, FEO landing sites will be limited, thus denying the joint force commander the ability to land at the place of choosing, limiting freedom of action and maneuver. Adding to the challenge of reconciling MCM, amphibious doctrine, space restraints on amphibious ships, and advances in enablers, the Navy-Marine Corps future procurements include the Ultra-

Heavy Lift Amphibious Connector (UHAC) and the future CH-53K's with a carbon fiber frame; both are contrary to *EF-21*'s and *CS-21*'s aim for smaller, faster, lighter, more austere enablers capable of MCM.

In addition, the increasing A2/AD proliferation and operational seam between the naval and land force create the potential for slowing the amphibious force momentum during *STOM*. Current USMC efforts include unmanned technologies for remote standoff detection, neutralization, proofing, and mitigation technologies.⁶⁶ Developing an in-stride SZ breaching capability, an EOD capability in the water, and/or an amphibious vehicle that supports doctrine facilitates a self-sufficient Marine Corps that ensures littoral access when conducting amphibious assaults against current and future threats and is in compliance with *EF-21*, CPG 2015, and EMW concepts. This capability could use the sub-sea as an additional maneuver space, but this would require a new craft that conducts the FEO lead-through of AAVs during the assault or the acquisition of a new USMC submarine troop connector capable of FEO and MCM (figure 11). This submarine amphibious vehicle will allow amphibious doctrine to take on and exploit additional maneuver space, the sub-sea. Utilizing the sub-sea as additional maneuver space, this craft could counter the A2/AD threats by avoiding surface movement and fully supporting USMC maneuver warfare concepts. This craft could also be capable of MCM, defeating twenty-first century A2/AD threats by exploiting gaps, achieve surprise, speed, maintain momentum, remain virtually undetected from ship to shore, and deliver combat power – where strategically required.



Figure 11. Source: Philip Pauley, Transatlantic Challenge Innovative Submarine Design, Culture Odyssey, Interactive Software Specialists, <http://www.philpauley.com/path.php>, 6 March 2016

Conclusion

Lieutenant General Charles E. Wilhem, USMC (ret), wrote, “For openers, minefields are not perfect. There will be gaps ... These are the gaps we must find and exploit.”⁶⁷ The vision of *STOM* is the seamless transition of MCM operations from DW through the objective inland by significantly shortening the MCM timeline and eliminating requirements for manned operations in minefields.⁶⁸ Regardless of coordination efforts, smooth transfers of authority between the CATF and the CLF, and brute force breaching of the SZ as it exists today, the fact is that within the *STOM* concept of operations there is a seam in what is supposed to be a seamless ship to objective maneuver. As long as the requirement to conduct *STOM* without a loss of momentum exists, US amphibious forces will always encounter this seam. If the line of demarcation is determined to be prior to or within the SZ, the issue of ownership for SZ breaching becomes a CLF responsibility. Currently, lack of clearly defined ownership, backed by

the capability and capacity to breach the SZ, adds to the complexity of amphibious operations, jeopardizing smooth transfer authority to the responsible service commander. To this end, the USMC is the service with the AAVs and is missioned with FEO in a non-permissive environment therefore, the USMC must obtain the capability and capacity to conduct in-stride breaching within the SZ.

STOM amphibious assault doctrine in a mine environment continues to increase as a critical issue for the Navy and Marine Corps, even more so today with A2/AD proliferation and population density within the littorals. A *STOM* type assault conducted in a mine and obstacle environment would be extremely difficult using current MCM assets.⁶⁹ In addition, due to expanding the littoral region by including numerous LPPs, and a fundamental paradigm shift away from linear movement to the beach as seen in the amphibious operations of World War II, enemy coastlines will have exploitable gaps.⁷⁰ The key to exploiting these gaps is, at a minimum, to develop and acquire the capability to conduct in-stride breaches of the littoral penetration points used by the landing forces in forcible entry operations. The Marine Corps will need to consider its role of MCM in the water during amphibious assault, from the VSW zone inland to the objective, if it ever seeks to build the capacity within its engineer and EOD community.

Until the operational seam between the Navy and the USMC MCM efforts are fully sewn into joint doctrine, the full intent of *STOM* is in jeopardy. Even though “naval forces” have a mission requirement to conduct rapid breaching of mine and obstacle fields to support amphibious landings, the roles and missions related to SZ breaching are muddy and turbulent in joint doctrine today. For this reason, the Marine Corps must first determine the requirements and specify the capabilities to be achieved. According to all

the studies conducted in 2015, the Marine Corps requires an organic EHD capability starting from the VSW zone on inland to the objective. Because the in-stride mechanical breaching capability appears to mitigate much of the SZ risks of conducting FEO in STOM, the capability itself transcends warfare communities and service components.

The USMC cannot be hindered by the use of mines, UWIEDs, or obstacles by an adversary; however, just as important, this should not prevent us from accomplishing the full intent of our EMW doctrinal concepts due to the inability to adapt to a critical naval amphibious operational deficiency in a mine environment. The recommendations to build the capacity and capability to defeat explosive hazards and breach mines in-stride are complimentary to one another and adhere to the *EF-21*, *CS-21*, EMW, and *STOM* concepts for amphibious warfare into the 21st Century.

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