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MASTER OF MILITARY STUDIES


TITLE: CLOSING THE FIRE SUPPORT GAP IN AMPHIBIOUS OPERATIONS

SUBMITTED IN PARTIAL FULFILLMENT
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MASTER OF MILITARY STUDIES

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Preface

The lack of Naval Surface Fire Support (NSFS) is a very interesting topic to me. A great amount of money, technology, and time spent on furthering our capabilities with respect to ground delivered and aviation delivered fires. This is certainly warranted, productive, and successful; however, leaders have done very little development concerning NSFS. There is a lot of research, ideas, and proposals that leaders and experts developed; however, the Navy only procured one of those ideas despite other, potentially more cost effective, ideas that experts brought to the table. My research did not focus on coming up with a brand new idea that would take well over a year to prove or disprove its fidelity and feasibility; rather to understand and synthesize other ideas and incorporate them into one singular solution. These ideas do need to be tested, simulated, and go through a cost analysis by engineers and economists but I believe, as many others do, that the ideas are certainly feasible.

I would first like to thank Dr. James Joyner for his guidance, mentorship, and assistance throughout this process. He certainly provided me with the guidance and direction I needed to complete this process. Additionally, thank you to Dr. Rebecca Johnson and LtCol Brian Ross for insisting that I stay the course in completing this paper as well as the guidance and mentorship that they provided. Finally, I would like to thank my wife, Stephanie, for the love and continued support throughout my career.

Executive Summary

Title: Closing the Fire Support Gap in Amphibious Operations

Author: Major Anthony C. Della Costa, United States Marine Corps

Thesis: In order to close the current gap within the fires triad, the Navy and Marine Corps team needs to continue to develop new systems, upgrade and equip existing platforms, and develop more sustainable and effective education opportunities for artillery officers of all ranks.

Discussion: Because of the decommissioning of the *Iowa*-class battleships in 1992, the Navy and Marine Corps team has a fire support gap within their fires triad in support of amphibious operations. This gap exists between the shortfalls of aviation fires and ground fires. Naval Surface Fire Support (NSFS) traditionally fills this gap. The current platform, mounted on destroyers and cruisers, is the five-inch fifty-four caliber gun. With a range of 13 nautical miles and no precision guided munitions, this platform does not meet current Marine Corps requirements in accuracy, range, and lethality. To answer the current requirements, the Navy developed the *Zumwalt*-class (DDG 1000) ship with upgraded weapon systems and capabilities. Officials originally planned for twenty-four of these new ships, but with the rising price tag, which ultimately reached about three and a half billion dollars apiece, this number dropped to three. This falls short of the Marine Corps' requirement. Additionally, shortfalls in artillery officers' education continuum widen this current gap as very little follow on education opportunities exist after Military Occupational Specialty School. The Navy and Marine Corps team needs to develop new, cost effective platforms that will meet the Marine Corps' current and future needs and requirements as this is a relevant capability for future operations in and around the littorals. Furthermore, the Marine Corps needs to develop sustainable and effective education opportunities in order to ensure competency of all artillery officers throughout their careers.

Conclusion: Fiscal restraints will always plague the armed forces with respect to designing and procuring new systems and platforms. However, looking at systems that are already developed, increasing their capability, and incorporating them on platforms that already exist may be the most cost effective and feasible answer to developing systems that meet the Marine Corps' requirements for NSFS. Finally, increasing course availability and requiring all fire supporters to attend follow on education will increase capability and competency of all artillery officers.

Introduction

As the nation refocuses its efforts on the Pacific and addresses potential adversaries in and around the littorals in that region, the Navy and Marine Corps team needs to ensure that the development and procurement of essential fire support platforms is at the forefront of capabilities development moving forward. Successful amphibious operations depend greatly on the fires triad of air, land, and sea platforms. The decommissioning of the *Iowa*-class battleships in 1992 created a fire support gap between aviation and ground fires.¹ Closing this fires support gap is essential to ensure that ground troops have the support needed at all times and all phases of an operation in and around the littorals.

Fuel and weather constraints limit aviation and ground platforms require a secured beachhead prior to going ashore, limiting the amount of fire support for the maneuver element. The fire support gap exists when the constraints of aviation and ground platforms overlap. Naval Surface Fire Support (NSFS) traditionally fills this gap and for over twenty years, the Navy has attempted to procure an answer to the Marine Corps' requirement of filling this shortfall. Ultimately, the Navy developed the *Zumwalt*-class battleship with new technology and advanced weapons systems. However, the rising cost of this new ship forced the Navy to reduce its acquisition drastically by cutting the amount from twenty-four to three, which is well short of the Marine Corps requirement.

The Navy and Marine Corps team should develop NSFS platforms that are more effective and efficient to close the fire support gap and complete the fires triad in support of amphibious operations. This team should create new systems, upgrade and equip existing platforms, and thus provide assets that will be adequate for the established NSFS requirements and could potentially be much more cost effective than existing or current plans.

Additionally, shortfalls in the current education continuum for artillery officers widen this gap in capability. The Marine Corps should develop sustainable and effective education opportunities by offering more courses and requiring all artillery officers to attend these courses throughout their careers regardless of the billets they hold, resulting in more competent and prepared fire support officers at all ranks and positions.

Current Capabilities and Limitations Define the Gap

According to the most recent Joint Publication (JP) 3-02 Amphibious Operations, “properly planned and executed lethal and nonlethal supporting fires are critical to the success of an amphibious operation.”² This publication continues to address the importance of fires and states, “during combat operations, maneuver, in conjunction with fires (organic and supporting) is essential to gaining access where the enemy least expects it.”³ JP 3-02 further explains, “Until ground fire support means (e.g., mortars, rockets, and cannon artillery) of the landing force are landed and ready to provide support, fire support is provided by close air support, naval surface fire support, and, in limited cases, direct and indirect fires from adjacent friendly forces.”⁴ Joint doctrine heavily documents the importance of fires in support of amphibious operations and planners, experts, and leaders should give all fire support assets the attention they deserve concerning development and procurement.

According to the 2006 Government Accountability Office report titled “Challenges Remain in Developing Capabilities for Naval Surface Fire Support:”

Since land-based artillery is restricted by the need for a large presence ashore, and air-based fire support can be restricted by weather conditions, the importance of sea-based naval surface fire support increases. The depth of operations envisioned requires ship-based guns and other systems with considerable range, while the speed and mobility envisioned demand rapid response times. Fire support for expeditionary forces also requires accuracy and precision, to increase the probability that targets are destroyed or disabled and reduce the possibility of Marines being killed when calling for munitions to land close to their own positions. Sustainability and lethality are needed as well to

compensate for the firepower removed from Marine units to preserve their speed and agility. These requirements surpass the abilities of the Navy's existing 13 nautical mile range 5-inch guns, necessitating the development and fielding of new weapon systems or the risks in executing expeditionary operations.⁵

Engineers developed and procured advanced platforms and weapon systems with respect to aviation and ground delivered fires but not much with respect to NSFS. Even with these new developments, the gap within the fires triad still exists. A quick discussion of the current platforms and their capabilities and limitations will better illustrate this gap.

Aviation Fires

Aviation provides an outstanding fires platform in both the deep and close fights. Currently the Marine Corps possesses two fixed-wing fire support platforms (the AV-8B Harrier and F-18 Hornet) and two rotary-wing fire support platforms (the AH-1 Cobra and UH-1 Huey). These current airframes provide close air support (CAS), deep air support (DAS), and some are able to perform air-to air combat missions. The fixed wing aircraft provide a number of capabilities and support missions to the ground commander. Additionally, they can provide DAS for deep strike packages and shaping operations, which prepare the battlefield for the ground scheme of maneuver. They can provide CAS, which provides close fires in direct support of the ground scheme of maneuver. They complete these missions with a number of versatile weapon systems. The capabilities are best explained by author Dan Alex who says that, "Options include the AGM-65 Maverick air-to-surface missile, the AGM-84 Harpoon anti-ship missile, up to 4 x AIM-9 Sidewinder short-range or AIM-120 AMRAAM medium range air-to-air missiles, conventional drop bombs, laser-guided bombs, cluster bombs, napalm and Joint Direct Attack Munitions – the latter making lethal use of GPS guidance."⁶ Rotary wing assets provide CAS using rockets and guns capable of destroying a number of target sets to include moving targets and armor.

Aviation is an extremely vital and effective asset but is incapable of providing support 24 hours a day, seven days a week. For example, weather restrictions caused the cancellation of 50 percent of all scheduled airstrikes on known or suspected targets during the 1999 operation in Kosovo.⁷ While systems have advanced slightly and aircraft have improved in the intervening sixteen years, weather vulnerabilities remain. While the Marine Corps' fight has focused on desert environments where weather was not as much of a factor, potential operations in the Pacific region would bring more adverse weather conditions.

A second limitation is enemy anti-air capabilities, which planners cannot overlook or disregard. Potential enemies continue to advance their air-defense capabilities. For example, Russia was selling Iran its S-300 missile defense system, a deal originally made in 2007 and later revived in 2013.⁸ Of note, this transaction and transfer is set to take place between 2015 and 2016.⁹ This weapon is capable of shooting down aviation assets at ranges of 90 miles away and up to 90,000 feet in altitude.¹⁰ These capabilities would remove US air supremacy early in the fight, creating the requirement to fly higher and faster, thus severely limiting US ability to provide close effective fires; at the extreme, commanders could ground aviation until the anti-aircraft threat is neutralized.¹¹

Planners need to destroy these potential air defense sites early in an operation. Because this would take place during the early phases of an operation, ground delivered fires is not an option. In the initial phases of an amphibious operation, a platform needs to be capable of filling aviation's potential shortfalls in destroying all potential anti-air defense assets. These fires need to come from another reliable and effective platform. In other words, something needs to cover the potential absence and/or limitations of aviation prior to ground fires getting ashore.

Ground Fires

Within the ground delivered fires realm, not including the 60 and 81mm mortars organic to the maneuver battalion, the artillery community possesses cannon artillery (the M777 lightweight howitzer), 120-millimeter mortar systems (the Expeditionary Fire Support System or EFSS), and rockets and missiles (the High Mobility Artillery Rocket System or HIMARS). The Marine Corps has dedicated roughly two and a half billion dollars to the development of these assets that are now fully fielded throughout the regiments.¹² Thus, the Marine Corps artillery “now has long, medium, and short range capabilities that should grant it the flexibility needed to support any contingency.”¹³ This, of course, is dependent on getting these assets ashore.

EFSS provides the Marine Corps with an extremely agile and mobile asset capable of providing earlier fire support as compared to the M777. Capable of traveling to shore from over the horizon in the MV-22 Osprey, EFSS has the capability of supporting troops earlier than standard artillery. Its primary mission, or purpose, is to provide direct support to a vertical assault element during an amphibious assault.¹⁴ This system has a supportability of up to 72 hours upon landing with the vertical assault element, which should allow for follow on fire support assets and vehicles to arrive ashore.¹⁵ Additionally, a battery of 120-millimeter mortars saves over 1000 square feet of deck space on a ship as compared to cannons.¹⁶ However, EFSS comes with a number of disadvantages that will point out a relatively serious gap in fires if not reinforced. These include, but are not limited to, range, time of flight, and the number of assets it takes to get ashore. More specifically, it takes 17 Ospreys (the primary aviation transport platform for EFSS) to fly an entire EFSS battery to shore with only 30 rounds per mortar.¹⁷ This takes time and resources and may require fire support while it is moving ashore.

Fielded in 2005, the M777 is the Marine Corps’ lightweight-towed howitzer. It fires the 155-millimeter projectile using either a manual system or the new integrated automated system

that self-locates the howitzer and is capable of receiving firing data digitally. The automated system reduces response time and human error. Furthermore, with the automated system and the development of the Excalibur round, the M777 is capable of providing precision strikes at close to 40 kilometers with a very high success rate.¹⁸ This system is a proven combat asset providing the ground commander more options and flexibility. However, M777 batteries require a large logistical footprint and take time to get ashore. A CH-53 can externally lift the M777 but it takes four sorties to get two guns and the minimum equipment and personnel necessary to fire the guns. Therefore, fire support is required prior to getting the M777 ashore whether by air or by sea.

HIMARS began fielding during the summer of 2007. The one active duty HIMARS battalion in the Marine arsenal is capable of providing pinpoint accuracy over a wide range and provides the maneuver commander with yet another all-weather option for both close and deep strikes. Standard rockets can range out to 32 kilometers with a capability of extending that range to 45 kilometers with the extended range rocket.¹⁹ Guided rockets can reach out past 75 kilometers and the guided missile can range out to 300 kilometers.²⁰ Yet the system takes time to get ashore and rotary-wing assets cannot fly them ashore. Therefore, either they need a secured landing strip to fly in or they use large amount of landing craft assets to get ashore. So, while HIMARS provides an effective and viable option to aviation on deep targets for the ground commander, it is not available in the initial phases of an amphibious operation.

Naval Surface Fire Support

Understanding the capabilities and limitations of air and ground delivered fires illustrates the gap that effective NSFS traditionally fills. After the decommissioning of the *Iowa*-class battleships, the Navy and Marine Corps team needed to rely on the 5-inch guns mounted on the

destroyers and cruisers.²¹ These guns fire ordnance that is slightly smaller than the standard 155mm round fired out of the Marine Corps' M777 lightweight howitzer with a current range of 13 nautical miles or approximately 23 kilometers.²² Their size results in slightly reduced effects as compared to the 155-millimeter projectiles; however, the guns' high rates of fire, which is approximately 16 to 20 rounds per minute, result in effects that are equivalent to that of an artillery battery with all six lightweight howitzers.²³ The range of the 5-inch guns presents a serious problem because of the current desired standoff of 25 nautical miles due to the increasing advancements of Anti-Access Area Denial (A2AD) threats. As stated in a report by the Amphibious Capabilities working group in 2012, "many states have significant over-the-horizon, precision strike systems, and the proliferation of precision weapons on the tactical battlefield is even more widespread."²⁴ While 25 nautical miles certainly does not take the ships out of danger, it is currently the most feasible, over the horizon, martialing area.²⁵

In addition to the five-inch guns, the Navy does have the capability of firing long-range cruise missiles. However, the Navy does not employ these assets for NSFS, reserving them for Naval Surface Strikes, or NSS. NSFS is in support of maneuver and provides the ground commander with the support he needs at the time and place he needs it. NSFS functions and is controlled in much the same way as ground delivered fire support assets with a fire support coordination cell controlling and allocating fires.²⁶ This provides the commander on the ground with the fires and effects desired and needed in a more responsive manner. Conversely, NSS engage particular targets in support of strategic objectives and is not necessarily in support of the ground scheme of maneuver. This is important to understand because NSS missions are typically executed independent of the ground force commander, rather than in conjunction with, and much of the current weapon platforms focus on NSS.²⁷

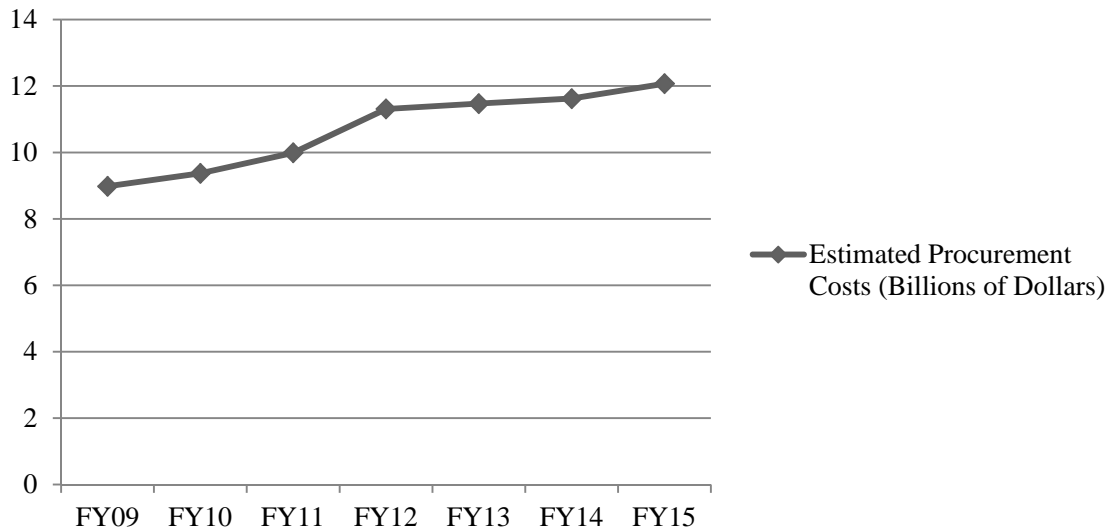
The Navy's current answer to the NSFS requirements (which will be addressed in detail shortly) and shortfalls is a newly designed ship with upgraded weapons systems and reduced crew requirements, the DDG-1000 *Zumwalt*-class destroyer. The first, commissioned on 12 April 2014, was the *USS Zumwalt*.²⁸ This class of destroyer is the largest of its kind in the history of the Navy and designed to provide the Marines with the NSFS they require.²⁹ The DDG-1000 is supposed to be the ship that will replace the capabilities lost from the decommissioning of the *Iowa*-class battleships.³⁰ The Navy developed the DDG-1000 over the past 20 years and began procurement in 2007.³¹ The Congressional Research Service succinctly explains its capabilities:

The DDG-1000 will have an integrated electric-drive propulsion system, a total-ship computing system for moving information about the ship, automation technologies enabling its reduced-sized crew, a dual-band radar, a new kind of vertical launch system (VLS) for storing and firing missiles, and two copies of a 155mm gun called the Advanced Gun System (AGS). The AGS is to fire a new rocket-assisted 155mm shell, called the Long Range Land Attack Projectile (LRLAP), to ranges of more than 60 nautical miles. The DDG-1000 can carry 600 LRLAP rounds (300 for each gun), and additional rounds can be brought aboard the ship while the guns are firing, creating what Navy officials call an 'infinite magazine'.³²

While this platform seems like a very capable ship, some issues accompany it. First, as is often the case with new technology, the expense of this new ship, which the Navy designed specifically for NSFS, is extremely high. The arrays of modernized weapon systems and stealth capability has pushed the price to nearly three and a half billion dollars per ship.³³

Announcement of the DDG-1000 was in late 2001 after the Navy decided to replace the DD-21 destroyer initiative that the Navy initiated in the mid-1990s.³⁴ Table 1 depicts the massive increase in the budget for three DDG-1000s and provides an understanding of the large expense created by developing an entirely new ship and weapons platforms.

**Table 1: Estimated Procurement Costs of the DDG 1000
(Billions of Dollars)**



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Table 1 depicts an estimated procurement cost going from about nine billion dollars to just over 12 billion dollars. This yields an overall increase of just over 3 billion dollars or 34.4%.

Second, Marine Corps Combat Development Command indicated that they require 24 of these new destroyers in order to cover the stated NSFS requirements around the globe.³⁶ However, during the initiation of this program, the Navy planned to procure 32 ships, taking into account magazine consumption, and add them to their inventory hoping to cover the Marine Corps' volume of fires requirements.³⁷ This number dropped to seven and then ultimately to three after the continued rise of the price tag and the Navy's over-reliance of the new weapon systems' capabilities.³⁸ With this said, these ships are scheduled to be sequentially operational in 2016, 2018, 2020.³⁹ Third, the *Zumwalt's* largest gun is the 155-millimeter cannon, which does not measure up to the *Iowa-class*' 16-inch, or 406mm, gun in potential capability and lethality, and has a range of only 83 nautical miles.⁴⁰ The 155mm has a weight of 100 pounds whereas the 16-inch round had a weight between 1750 and 2700 pounds, depending on the type of round.⁴¹ This is certainly significant from a lethality perspective and with new technologies aiding in extended ranges and precision accuracy, the 16-inch would certainly out-perform the 155mm in

overall capability. While the range of 83 nautical miles for the 155mm variant is certainly adequate for the mid-term, it does not meet the Marine Corps' far-term threshold of 97 nautical miles. This is concerning because currently this ship is the future NSFS platform.

While many of these current platforms provide very capable and much needed fire support, their limitations form that gap in their ability to provide the ground commander the support he may need in an amphibious operation. The lack of ability to provide proper fire support at any time may result in catastrophic outcomes for the maneuver force. Capable and efficient NSFS that meets the Marine Corps requirements is the answer to filling this gap. As stated by Colonel Shawn Welch, an artillery officer who conducted an analysis and testing of a potentially brand new NSFS capability in 2007, "current and programmed NSFS capabilities are insufficient to execute the Joint Forces Commander's littoral operational missions against a highly advanced regional or near-peer competitor without unacceptable risk."⁴² According to the December 2012 Annual Report to the Deputy Chief of Naval Operations for Warfare Systems, "NSFS, with necessary range and effects to support expeditionary operations in the littorals, is an essential complementary capability to aviation and ground-based indirect fires."⁴³ Gaining and retaining a capability that provides commanders with options is imperative for future amphibious operations.

Requirements

Requirements for fire support continue to change and update for all fire support platforms. Aviation continues to upgrade and refine its weapons, armament, and platforms while ground fires continue to improve their capabilities in range, lethality, mobility and accuracy. Examples of this are highlighted with the procurement and fielding of the HIMARS, EFSS, and M777. Another example includes the procurement of a GPS guided 155 millimeter round,

turning the M777 into a long-range indirect sniper rifle. Most of these programs are successful and fulfill the current needs and requirements. However, even with these upgrades the gap still exists because of the lack of upgraded and refined NSFS platforms. Prior to developing or upgrading NSFS, the Marine Corps needed to address its capability requirements from the short-term to the long-term.

The Marine Corps took a considerable amount of time identifying requirements, which can be partly to blame for the current shortfall of a capable and effective NSFS platform. After nearly ten years of working with the Navy, the Marine Corps and the Navy came to an agreement in 2005 concerning the requirements of an NSFS platform.⁴⁴ From 1996 to 2002, the Marine Corps produced three separate documents, each containing differences in required capability. For example, the Land-Attack Standard Missile (LASM) was the Navy's answer for a near-term weapon until a more advanced system came on line.⁴⁵ However, a change to the capabilities of requiring it to kill tanks, a capability it was not designed for, ultimately stopped development and forced development teams to go back to the drawing boards.⁴⁶ Another example that illustrates these changes is that of responsiveness. In 1996, the memo stated the requirement of a two minute, 30 second response time from call for fire to rounds landing on target and three years later, the memo stated a requirement of two minutes, 30 seconds from call for fire to rounds fired.⁴⁷ Finally, in 2005, the Marine Corps quantified all requirements, with the exception of volume, and created the *Joint Fires in Support of Expeditionary Operations in the Littorals Initial Capabilities* document.⁴⁸ Table 2 shows the basic requirements finalized in the last Marine Corps memo in 2002, which the Joint Requirements Oversight Council approved in the 2005 agreement.

Table 2: NSFS Basic Requirements

		Near-Term	Mid-Term	Far-Term
System Response	Threshold	2.5 minutes	2.5 minutes	2.5 minutes
	Objective	Limits of Tech	Limits of Tech	Limits of Tech
Range: Naval Guns	Threshold	41 NM	63 NM	97 NM
	Objective	63 NM	97 NM	Limits of Tech
Range: Other	Threshold	200 NM	200 NM	262 NM
	Objective	222 NM	222 NM	Limits of Tech
Accuracy & Precision	Threshold	50 m CEP	50 m CEP	50 m CEP
	Objective	20 m CEP	20 m CEP	20 m CEP
Target Acquisition	Threshold	50 NM	63 NM	97 NM
	Objective	63 NM	97 NM	Limits of Tech
Ordnance Effects	>Destroy or suppress point, area, and moving targets including personnel and material, and destroy hardened targets >Provide smoke, illumination, and incendiary effects			
Volume of Fire	>Volume fires are equally important to precision >Needed for mass fires, suppression and combined arms >Sufficient quantities are maintained to sustain desired effects			
Sustainment	>All systems sustainable via under way replenishment			

Note: The information contained in this table was derived from the United States Accountability Office report titled “Challenges Remain in Developing Capabilities for Naval Surface Fire Support” dated November 2006 on page 10.

- Threshold refers to as the minimum accepted and objective refers to desired
- CEP refers to Circular Error Probable

Understanding the requirements of the Marine Corps is certainly important when developing and testing new systems and capabilities. Unfortunately, publishing these requirements took about 13 years following the decommissioning of the *Iowa*-class battleships.

Future Systems, Problems, and Recommendations

Addressing the limitations of current systems, training, and education in support of amphibious operations is certainly an expensive and daunting task. Since 1992, programs and design teams from a number of corporations have attempted to resolve these limitations for the

future of amphibious operations. With the increased A2AD threat across the globe, these program teams are attempting to develop weapon systems that provide the accuracy, range, volume, and lethality that is required to accomplish the mission with limited risk. The Navy and Marine Corps need to place a great deal of effort in the short term to add capacity and potentially increase capability in order to meet the demands of potential worldwide conflicts. The *Zumwalt*-class is a start in fixing the existing gap in fires but does not provide or meet all requirements for a NSFS platform. There are many recommendations and ideas on fixing this shortfall; however, more success is possible if experts look at combining multiple ideas into a combined effort.

Shawn Welch developed a simulation in which to test capabilities provided by a DDG-1000 against, what he called, a Capital Surface Warship (CSW).⁴⁹ This simulated ship was fitted with a number of capabilities: 16 inch projectiles with Search and Destroy Antiarmor Munitions (SADARM) and extended range capability, precision guided projectiles with long range capability and a large magazine capacity, and short range projectiles with large magazine capacity.⁵⁰ The results of the simulation were staggering. The 16-inch SADARM weapon system on the CSW proved to be the most effective and was even more effective than aviation against all types of targets including those types of targets typically engaged with aviation assets.⁵¹ The only drawback to this course of action is the requirement to build an entire new ship with these upgraded weapon systems. While the idea and plan would reduce costs in weapons development, it would increase in ship development and be very close to the cost of the already developing DDG-1000, though much more capable.

Benefits certainly develop from the CSW idea with the larger caliber weapon systems. A number of naval officials and others say that the large caliber guns would not be able to range targets at the requirements set forth by the Marine Corps.⁵² In fact, contrary to this belief, from

1968-1969, the army, using 16-inch atomic cannon projectiles, conducted successful tests with their land-based 16-inch guns (closely resembling those 16-inch guns on battleships), demonstrating effectiveness at ranges of 50 plus nautical miles.⁵³ The development and tests were relatively inexpensive for the time and certainly proved their relevance. Referencing back to the minimum NSFS requirements, ranges tested at over 50 nautical miles exceeds the Marine Corps' near-term 41 nautical mile threshold for naval guns and is only 13 nautical miles short of the mid-term requirement of 63 nautical miles.⁵⁴ This is very significant as this weapon system can certainly provide the support needed from naval guns and could potentially increase in capability with over 40 years of technological development in weapon systems since those successful tests in 1969.

Rather than focusing on a brand new weapon system or munitions, experts and planners should look at upgrading existing platforms and munitions with upgraded fuses, rocket boosters, and deployable fins for precision strike capability, just to name a few. Moreover, at 16-inches, these rounds certainly provide the impact the Marine Corps requires in lethality and would reduce the volume requirements. Additionally, as stated by Welch, "Improvements in ballistic shape (such as the 'Moore Shape' designed by Dr. Frankie Moore of Naval Surface Warfare Center, Dahlgren also improves fragmentation pattern) can increase the range to approximately 100 nautical miles."⁵⁵ This surpasses Marine Corps requirements for both the mid-term and far-term thresholds. Other efforts have proven viable with the 16-inch platform. Conceived, but unfortunately never tested, by the Pratt and Whitney Company in 2003 was a 400 nautical mile scramjet projectile with an initial assessment of a nine-minute time of flight at its maximum range.⁵⁶ This is just another example of the feasibility of upgrading an already developed weapon system to achieve desired results.

In addition to the 16-inch platform, the HIMARS launcher system can potentially fit onto a ship. The question is whether the HIMARS launcher system can fit ships already designed with the vertical launching system (VLS) while improving, if not maintaining, its current ordnance, range, and precision capabilities. As previously stated, the HIMARS system currently provides standard rockets (32-kilometer range), precision guided rockets (70-kilometer range) and Army Tactical Cruise Missile Systems, or ATACMS (300-kilometer range). The rockets could either augment or temporarily replace 8-inch configurations with comparable payloads while the ATACMS could augment or temporarily replace 16-inch configurations.⁵⁷ Research and development could prove to be useful by augmenting other improved weapon systems and assist in solving the current NSFS problem.

Experts should continue to develop innovative and cost effective ways of implementing and upgrading weapon systems that are already developed; however, the development and potential capability that the new electromagnetic railgun (EMRG) system is a risk worth taking due to its potential capability of becoming a force multiplier with regards to NSFS. US Navy Commander Michael Ziv, who holds a master's degree in mechanical engineering from MIT and was the assistant program manager for the EMRG states that, "EMRG concepts have been around for years with their promise of lower cost per shot, increased safety, and reduced logistic tail."⁵⁸ This system uses electric current that creates an enormous amount of pulsed power.⁵⁹ This electric current is anywhere from three to five million amps, which generate enough electric pulse to launch a projectile anywhere from 50 nautical miles to 200 nautical miles.⁶⁰ Experts project that the long-range EMRG will be operational between 2020 and 2025 and is planned to function on a number of platforms such as the new DDG-1000, Littoral Combat Ships, DDG-51s, and civilian ships.⁶¹ The trajectory of an EMRG round may allow for reduced requirements

for airspace deconfliction while the speed of the round will reduce time of flight at extremely long ranges, creating a viable solution to timely fires with extreme accuracy. Ziv explains:

Range is adjusted mainly by varying the firing angle, with a peak altitude of approximately 800,000 feet at 50 nautical miles and approximately 500,000 feet at 222 nautical miles. Muzzle velocity will be approximately 2.5 kilometers per second, about Mach 7.5, with an impact velocity of about Mach 5.0. During its flight trajectory, the projectile spends approximately 5 minutes of its 6-minute flight above the sensible atmosphere (greater than 100,000 feet), thus simplifying airspace deconfliction and susceptibility of the projectiles to jamming. Circular error probability is predicted to be approximately 5 meters, based on anticipated projectile technology advances.⁶²

In addition to developing ways of upgrading already developed and tested weapons platforms and continuing development of the EMRG, the ideas of upgrading, refitting, and rearming already built ships needs to be addressed. An example of upgrading already built ships was the potential reactivation of the *Iowa*-class battleships. In order to lower the cost and potentially field essential naval surface fires platforms in a timely fashion, the Marine Corps looked at this as a viable option. William Stearman, a former naval officer and retired Senior Foreign Service Officer who served as a member of the National Security Council for four presidencies, explains that:

In the 19 November 2004 General Accountability Office report on NSFS, the Marines had the temerity to support the reactivation of two remaining deactivated *Iowa*-class battleships (*Iowa* (BB61) and *Wisconsin* (BB64)) in the face of an unjustified Navy animus against these ships. The admiral project manager for the DDX 1000 program, then correctly realizing that battleships posed a major threat to his program, launched a full-court press anti-battleship campaign on the Hill based mostly on disinformation, some of which I personally witnessed. This convinced Congress to get rid of these ships by donating them as museums to California and Virginia.⁶³

These two ships, the *Iowa* and the *Wisconsin*, would serve as excellent candidates that engineers could modify with modern weapon systems to include missile and rocket systems, 16 inch, 8 inch, and 5 inch guns.⁶⁴ These newly constructed or modified battleships would certainly provide the Marines with the NSFS they require to support operations ranging from raids or Non-combatant Evacuation Operations to full-scale amphibious assaults on contested and/or

heavily defended beaches while being tagged with a much lower price. According to a study conducted by the Joint Advanced Warfighting School in 2007, the estimated cost of converting or modernizing these battleships would come at a cost of approximately one billion dollars apiece. This price tag is far less, about two and a half billion dollars, than that of the DDG-1000 and engineers could potentially complete it within two years.⁶⁵ While reactivating, refitting, modernizing, and updating old battleships is a potential option and an economical idea, the very feasibility seemed to be lost when the Navy destroyed the entire infrastructure in the remaining *Iowa*-class battleships in 2010 and shattered the idea of real cost effective reactivation.⁶⁶ However, engineers should conduct a cost analysis to see how much over the estimated one billion dollars it would be if engineers were to replace that infrastructure because it may still prove to be an excellent option to supplement the DDG-1000.

Another idea, which can be very feasible, is to take the developed and proposed weapon systems that were on the simulated CSW and the *Iowa*-class battleships and integrate them on a completely different, yet capable platform, such as supertanker ships or other types of black bottom shipping. Kenneth S. Brower, the country's leading naval feasibility architect, argues that converting a supertanker would provide not only a very survivable platform but also could perform multiple functions other than just NSFS.⁶⁷ The very deck on a supertanker could accommodate a very large number of aircraft to include MV-22 Ospreys and could house a number of landing craft capable of bringing a sizeable force ashore.⁶⁸ Ultimately, this ship could potentially provide not only the NSFS that is required, but also a Marine Expeditionary Unit (MEU) as well.⁶⁹ While the legwork needed to construct something of this caliber and capability would certainly take some years to complete, the benefit could be insurmountable. Some say the cost of this project could reach about four billion dollars per ship.⁷⁰ While this seems like a very

large price tag, if in fact it can act as an amphibious ship capable of housing a MEU, the cost then becomes very reasonable and cost effective given the Navy and Marine Corps' current shortage of amphibious shipping.

Shortfalls in Training Increases the Gap

While current NSFS platforms provide limitations to the ability to achieve full fire support coverage during all phases of an amphibious operation, so too does the level of training provided to artillery officers. In order to increase capability of fires in support of amphibious operations, leaders should develop more opportunities and venues for training and education to give fire support professionals realistic and effective experiences.

Leaders expect all artillery officers to be the experts in all aspects of fire support.⁷¹ Yet many spend their entire company grade time in a battery having never served in a fire support billet. Officers who fall into this category never truly receive relevant and effective training and may not receive it into their more senior ranks as well. Aside from personal development and study, artillery officers are not trained adequately to be fire support experts and are not truly set up for success when given fire support roles.

Addressing the training and education concerns is essential in the development of fire support officers. According to the *Marine Corps Artillery Fire Support Training Standard Operating Procedure* (JRegtO P3570.2) it is ultimately the responsibility of the battalion and regimental commanders to ensure proper fire support training exists and these commanders are responsible for providing qualified fire support officers and fire support teams to the maneuver commanders.⁷² The argument is not in reference to the commanders' responsibilities to ensure the training of their personnel but rather to the opportunities and assets available to which the commanders can ensure their personnel's training.

Formal training and education opportunities post Military Occupational Specialty (MOS) schools exist primarily at Tactical MAGTF Integration Course (TMIC) in Twentynine Palms and at Expeditionary Warfare Training Group Atlantic and Pacific (EWTGLANT/PAC). If an officer is fortunate enough to attend TMIC and placed as the Fire Support Coordinator (FSC), he will benefit and gain a minimum amount of experience in planning fires in support of amphibious operations. TMIC does provide breakout courses but does not provide the required level of education needed to graduate as a proficient fires officer as it relates to amphibious operations.

Excellent training, concerning fire support, exists at EWTGLANT/PAC, which offer a number of courses that provide the realistic, relevant, and effective training and education required to make sufficient fire support officers, specifically concerning amphibious operations. EWTGLANT/PAC provides Joint Fires Officer (JFO) courses that focus on training individuals how to engage targets with all available assets to include naval surface fires and aviation.⁷³ Additionally, they offer an outstanding course on Fire Support Coordination (FSC), which provides essential skills to be a fire support coordinator in support of amphibious operations as well as in support of land and/or continuing operations.⁷⁴ These courses certainly provide excellent training; however, the problem is availability.

The FSC course provided by EWTG, for example, is a ten-day course offered only five times in a fiscal year.⁷⁵ With operational tempo, quota limitations within the battalions, and the limited amount of courses offered, battalions can only send those who hold or will hold a fire support billet within the battalion, which, of course, is not optimal. Battalions need to be afforded the opportunity to send all qualified individuals to these courses whether they hold the appropriate billet or not in order to further these individuals' training and education. This will

result in fully prepared artillery officers ready to plan, coordinate, and execute fires in support of amphibious operations. Artillery officers should continue their education throughout their careers to maintain proficiency within their trade as well as ensure their competency on new equipment and current tactics, techniques, and procedures. In the event that an officer or senior enlisted is put into a billet requiring extensive knowledge in these areas, he will already be prepared to meet the challenges simply based on the excellent education he has received throughout his career. While self-education and self-study are vital to the professional development of a Marine, the institution should provide proper training and education opportunities to artillery officers regardless of the billet held.

While new systems and ideas emerge, leaders need to look at ways to improve and increase training and education in order to understand these weapon systems and methods of employment. Providing all artillery officers with more education will ensure that quality Marine liaison officers that intimately understand the weapon systems and their capabilities can lead and train the NSFS team aboard a ship. As recommended by Frank E. Walker, “Assigning a combat arms Marine liaison officer as a permanent member of the ship’s company aboard the new *Zumwalt*-class destroyer [or any other NSFS platform] to advise the commanding officer on the many nuances of fire support integration would facilitate a greater degree of cooperation between Navy supporting capabilities and the supported Marine landing forces ashore.”⁷⁶

First, leaders should increase the number of classes for all courses, especially those dealing with fires, throughout a fiscal year at EWTGLANT/PAC to ensure artillery battalions have the opportunity to get all of their Marines the training that they need. This alone could double the throughput for the FSC course, for example, without changing duration of the course or its curriculum. Second, authors of the artillery doctrine and standard procedures should write

a segment in the JRegtO P3570.2 requiring all officers to attend a formal school regardless of the currently held billet. Within this write up, the author should identify which ranks are required for each course. For example, second lieutenants arriving in a battalion should immediately attend the Joint Fires Observer Course at EWTGLANT/PAC. This course will give the lieutenants the basic knowledge of all assets that planners can integrate into the fight and will assist them in the business of planning. First lieutenants should attend the Tactical Air Control Party course, which will give them information about the aviation component. This course gives individuals a working knowledge of conducting terminal attack control of close air support.⁷⁷ With many leaders placing emphasis and focus on aviation now and in the future, this is certainly a course that all officers should attend. Finally, upon returning to the battalions from their b-billets, all Captains should attend the FSC course. Requiring officers to attend these courses will not only provide them the training that they need, but will also ensure that the battalions work these courses into their training plans and ensure that their officers get to the courses. Finally, all senior captains/majors should be required to attend TMIC. Currently, this course is a requirement only for those holding the operations officer billet. This excellent course provides basic refresher training in fire support and gives the officer an excellent feel for operations as a whole.

Attending resident courses would be optimal but fiscal restraints can certainly influence the ability of battalions to send all officers to the resident courses: With that said, leaders can explore another avenue. Creating certified instructors and satellite courses within the regiments would also accomplish the same end state. TMIC is a course that should always remain a resident course, but EWTGLANT/PAC can be a satellite course. However, proper initial funding of the regiments is essential to provide the same training and education tools that exist at

EWTGLANT/PAC. Qualified instructors are the only way this recommendation can replace the training at EWTGLANT/PAC and leaders should view this assignment as a favorable billet, which will in turn attract quality people. The initial expense and loss of manpower for certification would be costly; however, the long-term benefits would be insurmountable.

Conclusion

Fires in support of amphibious operations are a necessity in order to conduct successful operations throughout the globe. This type of operation, according to Marine Corps Warfighting Publication 3-0, “envisions that the landing force will be supported by naval surface fires to augment its own land-based fire support.”⁷⁸ Throughout the years, a number of military officials and civilian engineers and experts have innovated, designed, procured, and developed a number of potential platforms that could potentially fill the current fire support gap that exists within the amphibious operations fires triad. As stated by LtCol Terry Branstetter, “Fulfilling identified NSFS shortfalls requires a combination of technology maturation and sustained investment.”⁷⁹ This requires a great deal of cooperation and committed support between Navy and Marine Corps officials.⁸⁰

The lack of commitment from the Navy certainly contributes to the current shortfall of NSFS since the early 1990s, while the Marine Corps shares some of that burden for not solidifying its requirements. Because of the growing A2AD threat among many states, the requirement for accurate, long range NSFS is extremely important. Over the last 20 years, significant developments in weapons system platforms have provided a number of workable, cost effective solutions to fulfill the near- and mid-term requirements. Incorporating systems such as the AGS, LRLAP, and VLS in conjunction with 16-inch platforms and HIMARS onto previously built ships can augment the new DDG-1000, providing the much-needed NSFS across

the globe. Additionally, the development and fielding of the railgun system can augment these newly upgraded NSFS ships with no issues.

Educating and training artillery officers are extremely important to understand, plan, and employ current and future weapons systems. Additionally, increased education opportunities result in more capable artillery officers throughout the Marine Corps and these officers will be ready to fill a fire support role and provide the recommendations and advice to the commander concerning all fire support assets that are at the commander's disposal. Furthermore, these true fire support experts should be aboard the NSFS platforms to train the NSFS teams and conduct operations. These are recommendations and capabilities that the Marine Corps should obtain and achieve to ensure its full capability as the nation's expeditionary, amphibious force.

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