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Equipping The NMESIS Battery

March 2022

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ABSTRACT

As the Marine Corps seeks to meet the strategic guidance set forth in the 2018 National Defense Strategy, the organization must replace legacy weapons systems that are less effective within the littoral combat area. As part of the Navy and Marine Corps Expeditionary Ship Interdiction System (NMESIS), the Marine Corps will incorporate the Naval Strike Missile (NSM) as one capability that will contribute to the Navy's freedom of maneuver within an enemy's weapon engagement zone (WEZ). Designated as the ROGUE-Fires system, the Marine Corps solution is an unmanned Joint Light Tactical Vehicle (JLTV) that has the ability to mount either the NSM or the Multiple Launch Rocket System (MLRS) family of munitions. This study's purpose is to assess the ideal equipping solution to ensure a NMESIS battery can accomplish its Training and Readiness (T&R) standards, assuming that it will be financially unfeasible to equip each unit with a full complement of 18 systems per battery. By limiting systems per battery in CONUS, the Marine Corps can reallocate additional funds toward replacing other legacy systems identified in Force Design 2030. Data used in the study included Total Force Training requirements, MOS-specific training objectives, and current unmanned system operators training objectives to formulate an example of likely T&R standards for a NMESIS battery.

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LIST OF ACRONYMS AND ABBREVIATIONS

A2AD	Anti-access area denial
ASM	Anti-ship Missile
DARPA	Defense Advanced Research Projects Agency
DIU	Defense Innovation Unit
DL	Distributed Lethality
DMO	Distributed Maritime Operations
DOD	Department of Defense
DRRS	Defense Readiness Reporting System
EABO	Expeditionary Advance Base Operations
GBASM	Ground Based Anti-ship Missile
HIMARS	High Mobility Artillery Rocket System
LBASM	Land Based Anti-ship Missile
LOCE	Littoral Operations in a Contested Environment
JCIDS	Joint Capabilities Integration and Development System
JLTV	Joint Light Tactical Vehicle
MCT	Marine Corps Task
METL	Mission Essential Task List
MOS	Military Occupational Specialty
MPF	Maritime Prepositioned Force
NDS	National Defense Strategy
NMESIS	Navy and Marine Corps Expeditionary Ship Interdiction System
ROGUE-Fires	Remotely Operated Ground Unit for Expeditionary Fires
SME	Subject Matter Expert
T&R	Training and Readiness
T/E	Table of Equipment
T/O	Table of Organization
TEEP	Training Exercise and Employment Plan
USMC	United States Marine Corps

UAV	Unmanned Aerial Vehicle
UV	Unmanned Vehicle
WEZ	Weapons Engagement Zone

EXECUTIVE SUMMARY

A. PROJECT SUMMARY

As the Marine Corps replaces legacy cannon artillery systems with remotely operated unmanned systems, decision-makers need to consider the effects of training individual operators instead of crews of Marines. Navy and Marine Corps Expeditionary Ship Interdiction System (NMESIS) battery commanders will be tasked with ensuring Training and Readiness (T&R) requirements are completed while shifting focus toward evaluation of individual operator skills. The number of Remotely Operated Ground Unit for Expeditionary Fires (ROGUE-Fires) systems a battery is sourced will be a determining factor in their ability to train individual Marines. For this study, I developed a set of training standards and associated training times to recommend a Table of Organization (T/O) and Table of Equipment (T/E) for the NMESIS battery. Assumptions that helped guide my recommendation were two-fold. One is that organic capabilities to provide force protection and self-sustainment must be maintained. The second is that budgetary constraints will play a role in both the personnel size and equipment allocation of the NMESIS battery.

B. METHODOLOGY

Since NMESIS training standards have yet to be identified, I compiled a list of 70 individual level tasks from three current T&R manuals and associated training times to each task. Known as 1000 and 2000 level tasks within the Marine Corps T&R process, these requirements were the basis for determining total training time for the unit. By converting total training time into days required to complete training, I was able to provide analysis on three separate manning tables using four separate equipment options.

My starting point for manning numbers came from the current T/O of a HIMARs battery which includes 60 artillerymen per unit (Total Force Management System, 2021). I then looked at reduction of training time when reducing the size of the unit into a 40-man and 20-man battery. Manning numbers were used against four equipment tables that include the initial Marine Corps proposal of 18 systems per battery, and reduction of equipment to 16, 12, and 8 ROGUE-Fires systems. The below table shows days required to complete individual level training based on the outlined combinations of manpower and equipment.

Table 1. Workdays Required to complete Individual Level T&R Task for independent Manning and Equipment Options.

Unit Size	# of ROGUE-Fires Systems	Workdays to complete
20 Marine	8	67
	12	45
	16	34
	18	30
40 Marine	8	134
	12	90
	16	67
	18	60
60 Marine	8	201
	12	134
	16	101
	18	90

Using a standardized Training Exercise and Employment Plan (TEEP) format, I outlined individual level MOS requirements plus additional training required annually for a battery. The additional training included battalion level exercises, regimental level exercises, division level exercises, service level exercises, Total Force training requirements, common to all T&R task, and basic combat skills requirements. Examples of 1st Marine Division artillery unit TEEPs over the last five years were used as the standard to gauge battery level participation in service level training exercises. This gave me an estimate of 38 days annually that a battery has available to complete individual level T&R tasks.

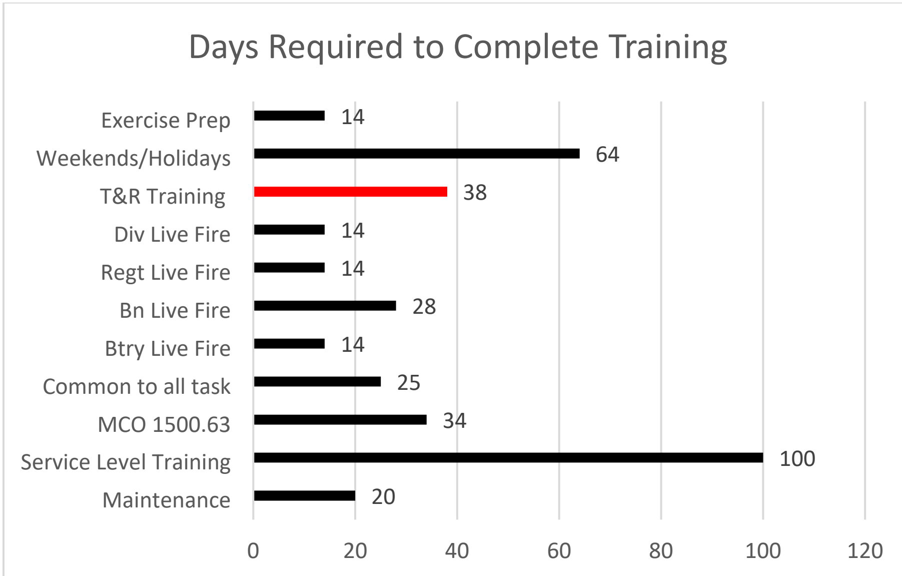

Figure 1. Training Days Required to Complete NMESIS Battery TEEP Events.

C. RECOMMENDATION

My recommendation is that the Marine Corps employs 40 artillerymen per battery, equipped with 16 ROGUE-Fires systems. This will provide the unit with three trained operators per system within a battery. Individual level training will take 67 days to complete, but battery commanders can mitigate that requirement through evaluation of senior operators during service level exercises. Procurement cost would be reduced by $4 million per battery, saving the Marine Corps $56 million. Personnel cost will also be reduced, helping the Marine Corps meet its manpower reduction goals outlined in Force Design 2030 (USMC, 2020). Tasks associated to force protection and self-sustainment could still be accomplished organically. Continuous fire support would be based on Marines operating the system on eight-hour shifts, then rotating between local security and rest time. Further considerations are explained in Chapter V of my thesis as to why other manpower and equipment models are not recommended.

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Total Force Management System. (2021). *Unit table of organization and equipment report: Rocket battery 5th Battalion 11th Marines 1st Marine Division*. United States Marine Corps.

United States Marine Corps. (2020, March). *Force design 2030*. https://www.hqmc.marines.mil/Portals/142/Docs/CMC38%20Force%20Design%202030%20Report%20Phase%20I%20and%20II.pdf?ver=2020-03-26-121328-460

I. INTRODUCTION

As the Department of Defense (DOD) realigns strategy to meet the needs of foreign policy, the Navy and Marine Corps team must look to reestablish common operating concepts that will succeed in future operational environments. This will require an integrated Naval Team that no longer develops concepts and systems based on individual service needs. Naval integration between the two services dates to 1775, when the Second Continental Congress passed a resolution that raised two battalions of Marines to serve as landing forces for amphibious operations, conduct seizure of advanced naval bases, and provide security aboard Naval shipping (Office of the Director of National Intelligence, n.d.). This Naval tradition must be reinvigorated to ensure future success within littoral combat areas around the world. To accomplish this, the Navy and Marine Corps have produced multiple strategic planning documents to align efforts and ensure interoperability. The primary lines of effort for the Marine Corps are codified in Force Design 2030, the service guidance on reshaping the force to meet future threats. One part of this integrated approach is the procurement of the Navy and Marine Corps Expeditionary Ship Interdiction System (NMESIS). This system is a remotely operated unmanned system that utilizes long-range precision strike anti-ship missiles (ASMs), designed to help provide Naval surface forces with freedom of maneuver within a littoral combat zone.

A. PROBLEM DESCRIPTION

As the United States Marine Corps (USMC) transitions units away from towed cannon artillery toward ASM formations, one challenge will be to determine the correct number of systems to equip a battery with to accomplish their Training and Readiness Standards (T&R), a tier-based training curriculum that includes individual and collective training objectives (Training and Education Command [TECOM], 2018). Historically, a team of Marines worked within specified roles to operate cannon artillery systems. Cannon batterie’s trained and deployed to combat with six howitzers. With the introduction of a remotely operated unmanned system, traditional cannon crews will be used to employ independent systems as opposed to working together to manipulate one system (Marine

Corps System Command [SYSCOM], 2021). This will increase the number of weapon systems a single unit can employ and allow the Marine Corps to distribute forces across a larger area of operations. Commanders will have the ability to surge or reduce equipment to meet their fire support requirements. Situations that require increased fire support will no longer require an additional unit, as one battery will have enough trained operators to provide additional artillery fire support with the introduction of prepositioned equipment through the Maritime Prepositioned Force (MPF). By reducing the number of personnel required to employ artillery fires, commanders can reduce the risk of additional casualties while maintaining fire superiority.

One issue with this employment technique is the budgetary constraints of procuring enough weapons to ensure the battery can train all individual system operators. The claim of budgetary constraints is supported by the Research and Development Project Cost Analysis that lists procurement cost per system at $2.1 million (Office of Management and Budget, 2019). The Marine Corps proposed unit Table of Equipment (T/E) would employ 18 Remotely Operated Ground Unit for Expeditionary Fires (ROGUE-Fires) platforms per battery, with the ability to surge as required from MPF, costing the Marine Corps $37.8 million per unit (SYSCOM, 2021). Also outlined within the proposed force design, the Marine Corps would field 14 NMESIS batteries across the active-duty artillery community (Senate Armed Services Committee, 2020). Those 14 units would account for a procurement cost of $529.2 million, not including additional life-cycle costs such as maintenance, program/software upgrades, and combat loss. According to the fiscal year 2022 budget request, the Marine Corps is seeking $47.9 billion to overhaul the force for littoral operations (Department of Defense [DOD], 2021). Given that the NMESIS is one of many new systems the Marine Corps is looking to adopt, budgetary constraints will play a major role in meeting T/E goals.

My analysis provides Marine Corps planners an equipping solution for a NMESIS battery, based on requirements to train individuals instead of teams and considering the time available to complete individual level training requirements. My intent is to show the effects that equipping will have on the battery's ability to become mission capable through the standard Marine Corps T&R process. Failure to source an adequate number of

ROGUE-Fires systems will result in degraded combat effectiveness and lethality on the battlefield. The study should also aid the development of equipment templates for units that will transition to unmanned systems in the future.

B. RESEARCH QUESTIONS

This study looks at three primary research questions.

1. What are the T&R tasks that will be required for individual operators?

I developed a set of 70 individual level tasks compiled from three current T&R manuals. The 70 tasks incorporate individual skills that deal with basic operation, employment, and troubleshooting of the system. After associating training times to each task, I used these requirements as the basis for my calculations on total time to complete training per equipment table.

2. What additional training requirements will limit the unit's ability to complete their T&R requirements?

To determine the amount of time a battery will have to conduct T&R training, I considered annual training requirements from multiple Marine Corps sources. Additional training included Total Force training requirements, common to all T&R task, basic combat skills training, and service level training exercises. Using a standard Training Exercise and Employment Plan (TEEP) format and historical data from 1st Marine Division units, I formulated an annual training plan to capture all required training.

3. How many ROGUE-Fires systems and personnel will a NMESIS battery need to accomplish their training requirements?

I analyzed three manning tables equipped with four different equipment solutions to determine the optimal number of systems per battery. Factors that helped determine my recommendation were the ability to complete T&R training while maintaining organic support and sustainment capabilities, internal force protection, continuous fire support, and the procurement cost of equipping a battery. I determined that a battery of 40 artillerymen equipped with 16 ROGUE-Fires systems would provide the Marine Corps with a force capable meeting both combat effectiveness and cost reduction requirements.

C. SCOPE

My analysis provides an equipping solution based on required training manhours, the proposed T/E per unit, and three manpower templates to offer an optimized equipping solution for a NMESIS battery. At the time of this research, the Marine Corps had yet to finalize a Table of Organization (T/O) or a T&R manual for a NMESIS battery. Using like systems, I developed T&R task, with associated training times and execution requirements, adapted from existing T&R manuals. I then developed a mathematical equation based on three different unit manning possibilities. This gave me an optimal equipping solution for the unit. I then incorporated Total Force Training, common to all T&R task, and service level exercise requirements into a notional Training Effectiveness Evaluation Plan (TEEP) to evaluate the available training time for a battery. My recommendation is based on providing Marine Corps decision-makers a solution that allows for training completion while limiting procurement and manpower cost. Consideration of life-cycle maintenance and infrastructure cost will be recommendations for further analysis to fully capture the impacts of procuring the new system.

D. STUDY DEFINITIONS

The definitions used in this thesis were pulled from original sources and are used to establish a common understanding of key terms. Technical descriptions of NMESIS were sourced from Marine Corps Systems Command, the lead development command for this acquisition project.

AirSea Battle (ASB):

> While ASB is not a strategy, it is an important component of DOD's strategic mission to project power and sustain operations in the global commons during peacetime or crisis. Implementation of the ASB Concept, coordinated through the ASB office, is designed to develop the force over the long-term, and will continue to inform institutional, conceptual, and programmatic changes for the Services for years to come. The ASB Concept seeks to provide decision makers with a wide range of options to counter aggression from hostile actors. At the low end of the conflict spectrum, the Concept enables decision makers to maintain freedom of action, conduct a show of force, or conduct limited strikes. At the low end of the conflict spectrum, the Concept enables decision makers to engage with partners to

assure access, maintain freedom of action, conduct a show of force, or conduct limited strikes. At the high end of the conflict spectrum, the Concept preserves the ability to defeat aggression and maintain escalation advantage despite the challenges posed by advanced weapons systems. (Air-Sea Battle Office, 2013)

Distributed Maritime Operations (DMO):

> The strategy describes the return to sea control and implementation of Distributed Lethality as an operational and organizational principle for achieving and sustaining sea control at will. Sea control is the precondition for everything else we must do as a navy. Distributed Lethality reinforces fleet initiatives that drive collaboration and integration across warfighting domains. Distributed Lethality requires increasing the offensive and defensive capability of surface forces and guides deliberate resource investment for modernization and for the future force. Providing more capabilities across surface forces yields more options for Geographic Combatant Commanders in peace and war. (Department of the Navy [DON], 2016)

Littoral Operations in a Contested Environment (LOCE):

> Concept introduces ideas on how naval forces could be organized, trained, and equipped to enhance their ability to operate in contested littoral environments. Included among those ideas are: additional, versatile force options; a wider application of existing doctrine; and the more flexible employment of current, emerging, and some potential capabilities. To confirm their integral merit, the ideas put forth in this concept require further testing and refinement through detailed wargaming, experimentation, and exercises. It is expected that these activities will invigorate and advance naval operational art and stimulate creativity on how to exploit the inherent synergy of integrated Navy and Marine Corps capabilities. Of particular importance, practical application of the concept during live exercises will allow naval forces to identify the inevitable seams and capability limitations that must be resolved. (DON, 2017)

Expeditionary Advanced Base Operations (EABO):

> A form of expeditionary warfare that involves the employment of mobile, low-signature, persistent, and relatively easy to maintain and sustain naval expeditionary forces from a series of austere, temporary locations ashore or inshore within a contested or potentially contested maritime area in order to conduct sea denial, support sea control, or enable fleet sustainment. (USMC, 2018)

Anti-access/Anti-denial (A2AD):

> Anti-access area-denial (A2AD) encompasses two distinct capabilities. Anti-access capability impedes force movement into a theater or causes forces to operate from distances farther from the locus of conflict than they would otherwise prefer. Area-denial capability impedes force maneuver within an area where an adversary cannot or will not completely prevent access. (USMC, 2021)

Weapons Engagement Zone (WEZ):

> In antisubmarine warfare, the area defined by a submarine datum expanded by a predicted furthest-on-circle and the maximum effective torpedo firing range (for a torpedo threat) or 2. The maximum effective missile firing range (for an anti-ship cruise missile threat). (NTRP 1–02) 3. The maximum range at which a combatant can detect adversary forces and effectively employ anti-ship missiles and land-attack missiles against them. (USMC, 2021)

First Island Chain:

> The first island chain consists of land and waterways bordering the northern, eastern, and southern edges of the South and East China Seas. Beginning at Singapore, the chain extends through the Riau Archipelago, along Borneo and the Western Philippines, including Taiwan and the Ryukyu islands north to mainland Japan, ending at South Korea's coastline with the Korean Strait. (Yoshihara, 2012)

Ground Based Anti-ship Missiles (GBASM):

> Anti-ship missiles consist of the anti-ship cruise missile (ASCM) "guided and powered … at constant speed for the majority of its route [using] aerodynamic forces for lift" as well as the anti-ship ballistic missile (ASBM) "that does not rely upon aerodynamic surfaces to produce lift and consequently follows a ballistic trajectory when thrust is terminated" (Joint Chiefs of Staff, 2017). GBASM are the missiles that will be deployed from the ROGUE-Fires system. (SYSCOM, 2021)

Navy and Marine Corps Expeditionary Ship Interdiction System (NMESIS):

> Provides the initial solution to the GBASM capability. NMESIS integrates a Naval Strike Missile (NSM) Launcher Unit, capable of launching 2 NSMs, onto a Remotely Operated Ground Unit for Expeditionary Fires (ROGUE-Fires) Carrier. The NLU is controlled by the Weapon Control System (WCS) located externally (external from the ROGUE-Fires Carrier) in a command-and-control vehicle. The ROGUE-Fires Carrier is controlled

by the ROGUE-Fires Leader Kit also located externally on a designated leader vehicle, which could also be the same command and control vehicle used by the WCS. (SYSCOM, 2021)

Remotely Operated Ground Unit for Expeditionary Fires (ROGUE-Fires):

The ROGUE-Fires carrier is developed by Oshkosh, Robotic Research and DCS Corp. ROGUE-Fires is a modified JLTV platform equipped with by-wire actuators and sensors as well as a remote operations kit developed by the Autonomous Ground Resupply (AGR) program. AGR is a Science and Technology Objective (STO) run out of CCDC Ground Vehicle Systems Center (GVSC) that originally funded the development of Leader/Follower software for the Palletized Load System (PLS) vehicles. The primary vehicle modes utilized on the ROGUE-Fires vehicle are Standby, Garrison, and Remote (Robotic). Remote mode is used for Tele-Operation (Tele-Op) and Leader/Follower operations. Teleoperation mode allows the ROGUE-Fires carrier to be remotely controlled through the Operator Control Unit (OCU) tablet and attached controller that are part of the ROGUE-Fires Leader Kit. The operator will view a forward-looking video feed and remotely control the ROGUE-Fires carrier with controls like the garrison controller. (SYSCOM, 2021)

Joint Light Tactical Vehicle (JLTV):

The JLTV family of vehicles is an Army-led, joint-service program designed to replace existing light tactical wheeled vehicle fleet while closing an existing capability gap. Intended to provide protected, sustained, networked mobility for personnel and payloads across the full range of military operations, the JLTV will act as the carrier for GBASMs. (SYSCOM, 2021)

ROGUE-Fires Leader Kit:

The leader kit contains the controls, display, radios and antennas to provide the one-to-many vehicle control and allows the operator to configure and execute leader and follower commands, view camera feeds for tele-operation, review alerts and provide assistance commands. The ROGUE-Fires uses two of the rugged controllers. One is for tethered Garrison-mode operation and the other is for Tele-Operation in remote mode. The leader kit is integrated onto the designated leader vehicle. (SYSCOM, 2021)

Naval Strike Missile (NSM) Launcher Unit (NLU):

The NLU is developed by Raytheon Missiles and Defense (RMD) and Corvid Technologies. The NLU mounts onto the ROGUE-Fires Carrier and can hold two En-canistered Missiles (EM), each weighing 1,984 pounds, at a length of 161.4 inches, 33.5 inches wide, and 35.4 inches in height. The Fire Control System (FCS) is developed by Kongsberg Defense and Aerospace (KDA) and is mounted between the EMs. The NLU is controlled by the WCS. (SYSCOM, 2021)

NSM Weapon Control System (WCS):

WCS provides control and response to the NLU. The WCS is integrated in the command-and-control vehicle and consists of the Fire Direction Terminal (FDT) (1), the Arming and Control Panel (ACP) (2), RF Link to the FCS (3), WCS Power and Distribution Control Unit (4) and a power supply (5). The FDT is a ruggedized laptop computer for mission planning, control, and maintenance of the NSM system. The FDT is the operator interface for both remote and local control of the NSM Launch Unit. (SYSCOM, 2021)

Tactical Communications Adapter (TCA):

TCA is a software application that enables participation in Link-16 and VMF networks and translates J and K messages to messages that are compatible with the FDT interface. (SYSCOM, 2021)

E. THESIS ORGANIZATION

Chapter I set the foundation for the study by establishing the problem statement, stating my research questions, identifying the scope of my research, and introducing definitions that help establish a common understanding of key terms. In Chapter II, I introduce the strategic guidance that is currently directing DOD force design and weapon procurement projects, then describe both Joint and Marine Corps plans to meet that objective. I also give a brief history and introduction to anti-ship missiles (ASMs). Chapter III looks at the current literature supporting three important factors of equipping unmanned systems: DOD guidance, employment scenarios, and studies on the manning of autonomous systems. Chapter IV provides a roadmap of the study methodology from the introduction of T&R standards, data development, and model design. Chapter V is my recommendation for equipping the NMESIS battery based on training requirements, employ considerations, and assumptions about budgetary constraints. I also provide recommendations for further research on topics that will impact total cost for ROGUE-Fires procurement as well as methods to reduce field training time.

II. BACKGROUND

A. STRATEGIC GUIDANCE

The current U.S. military strategy has shifted away from combating global terrorism toward great power competition with revisionist states and emerging global powers (DOD, 2018). Advances in technology have led to cheaper, more efficient, and more lethal systems designed to limit littoral mobility and defend territorial waters at greater ranges. Known as Anti-Access/Anti-Denial (A2AD) systems, cruise missile capabilities extend a coastal defender's attack capabilities past the range of the Amphibious Area of Operations (USMC, 2021). In 2012, the DOD published guidance directing military service chiefs to plan future operations "to project power despite A2AD" (DOD, 2012). This guidance, *Sustaining U.S. Global Leadership: Priorities for 21st Century Defense*, caused a ripple effect as service chiefs sought to identify shortfalls and develop joint-service concepts of employment.

Following the 2012 guidance, later policy statements reiterated this shift through the 2015 Chairman of the Joint Chiefs of Staff document *National Military Strategy* and the 2014 Secretary of Defense's *Quadrennial Defense Review*. These strategic documents reinforced a capabilities-based approach to the A2AD environment, with specific attention paid to the People's Republic of China and the Russian Federation. The *National Security Strategy* of President Obama (2015), President Trump (2017), and the *Interim National Security Strategic Guidance* of President Biden (2021) have all prioritized the focus of U.S. military resources toward littoral threat environments and a potential A2AD wartime scenario in the Western Pacific (White House, 2021).

The change in strategic direction is designed to shift focus toward "an increasingly complex global security environment, characterized by overt challenges to the free and open international order and the re-emergence of long-term, strategic competition between nations" (DOD, 2018). In 2018, a new version of the *National Defense Strategy* (NDS) was published under the direction of then Secretary of Defense General James Mattis. This document, the first of its kind since 2008, reoriented the direction of the DOD "from countering violent extremists in the Middle East to great power/peer-level competition, with special emphasis on the Indo-Pacific" (USMC, 2021).

This monumental change in strategic direction highlighted the need for every individual service to "make difficult choices and prioritize what is most important to field a lethal, resilient, and rapidly adapting Joint Force" (DOD, 2018). Within the Marine Corps, "sweeping changes" were required to transform the force from ground based focused operations toward littoral operations (USMC, 2021).

B. JOINT SERVICE CONCEPTS

Following the guidance of *Sustaining U.S. Global Leadership: Priorities for 21st Century Defense*, the Naval Service developed a strategy of Distributed Lethality (DL), which seeks to limit force exposure "by increasing the offensive and defensive capability of individual warships, employing them in dispersed formations across a wide expanse of geography, and generating distributed fires" (Commander, Naval Surface Forces, 2020). Also referred to as Distributed Maritime Operations (DMO), the Navy and Marine Corps intent is to reinforce fleet initiatives that "drive collaboration and integration across warfighting domains" (Commander, Naval Surface Forces, 2020). This mindset has allowed the Naval Service to begin developing future concepts and identify current capabilities gaps.

This collaboration resulted in several service level doctrines that have been produced to codify the way ahead. Central among these are the Navy's *Surface Force Strategy: Return to Sea Control* (2016), the collaborative concept of *Littoral Operations in a Contested Environment* (2021) and the Marine Corps concept of *Expeditionary Advance Base Operations* (2021). These key strategic documents established the framework to allow further experimentation, planning, restructuring, and development that will help facilitate mission success in the maritime battlespace.

While the Naval Service has had the primary role in developing future amphibious capabilities, the DOD must continue to look at this issue as a Joint Force. As described in the joint doctrine *AirSea Battle*, we must seek solutions to "set the conditions at the operational level to sustain a stable, favorable conventional military balance throughout the Western Pacific region" (Air-Sea Battle Office, 2013). *AirSea Battle* seeks

> integrated Air Force and Navy operational concepts that mitigate missile threats to U.S. bases; correct imbalances in strike capabilities between the United States and China's People's Liberation Army (PLA) in the Western Pacific; enhance undersea operations; offset the vulnerabilities of space-based command and control (C2) and intelligence, surveillance, and reconnaissance (ISR) systems; increase interoperability; and enhance electronic and cyber warfare capabilities. (Atler, Kelly, Nichols, & Thrall, 2013)

This will be accomplished by "integration of air, land, naval, space, and cyberspace forces to provide combatant commanders the capabilities needed to deter and, if necessary, defeat an adversary employing sophisticated anti-access/area-denial capabilities" (DOD, 2012).

C. THE ANTI-SHIP MISSILE (ASM)

One system that will aid the DOD in accomplishing strategic guidance is the ASM. Produced in a variety of surface-based and air-based launch platforms around the world, the ASM is a cheap and effective weapon employed to deter an enemy's ability to conduct Naval actions. While not new, this weapon system has grown in popularity over the last twenty years and will continue to be a key aspect of a country's A2AD arsenal.

We can trace the history of anti-ship missiles back to World War II. Nazi Germany introduced two versions of an air launched radio-controlled missile, resulting in high hit rate probabilities for that era (Piccirillo, 1997). In 1967, the first use of surface-to-surface anti-ship missiles were used to sink an Israeli destroyer, the *Eilat* (Hughes, 2000). Later, uses of both surface-to-surface and air-to-surface missiles were used during the Indo-Pakistani War of 1971, the Arab Israeli War of 1973, and the Falklands War in 1982 (Piccirillo, 1997).

Today, numerous countries have the capability to launch ASMs at varying ranges and from multiple surface or air weapons platforms. Future launch platforms are being developed that will include Unmanned Aerial Vehicles, loitering systems, and palletized systems (Center for the Study of the Drone, 2017). Advancements in missile capabilities can be seen as numerous countries are currently seeking to procure or develop hypersonic weapons that will extend range past 1000 km (Allison, 2021). Table 1 is a brief overview of the countries that currently produce their own version of the ASM.

Table 1. Primary Countries that Produce ASMs. Adapted from CSIS Missile Defense Project (2022).

Country	Name	Year	Range
China	YJ-18	2014	540km
Germany	RBS15 Mk 3	2011	200km
France*	Exocet	1975	180km
India	Nirbay	2020	200km
Iran	Ra'ad	2007	350km
Israel*	Gabriel	1972	400km
North Korea	KN-01	2017	200km
Norway**	Nytt sjomalsmissil	2012	185km
Russia	SS-N-22 Sunburn (Moskit)	2019	120km
South Korea	Haesong I	2005	250km
Taiwan	Hsiung Feng III	2020	400km
Turkey	Atmaca	2020	200km
USA*	Harpoon	1977	240km

* Denotes countries that export their variant globally.

** Bought by the U.S. and renamed the Naval Strike Missile (NSM).

Within the last 20 years, advancements in technology have reduced procurement cost and increased the capabilities of adversaries to acquire ASMs on a larger scale. Advancements in lethality, range, and precision will allow enemies to attack our Naval surface fleet beyond the maximum range of our surface connectors. Non-state actors now possess the capabilities to impede international shipping lanes and affect the global market, as seen during the 2018 Houthi attack on Saudi Arabian oil tankers in the Bab al-Mandeb Straits (Sharp, 2018). This new technology will also negate our ability to operate from Advanced Naval Bases located throughout the Pacific. Our ability to operate within an enemy's weapons engagement zone (WEZ) will be key to successful amphibious operations.

D. THE MARINE CORPS SOLUTION

As the Marine Corps shifts focus toward aligning our force structure to meet the needs outlined in the 2018 NDS, we must continue to look at legacy weapon systems that do not facilitate the accomplishment of that mission. Within the artillery community, the shortfall in expeditionary precision fires has been a key focus to ensure we can fully integrate with the Navy to accomplish our strategic objective (USMC, 2021). To accomplish this task, the Marine Corps will transition from medium towed cannon artillery to precision guided missiles through the employment of High Mobility Artillery Rocket System (HIMARS) and the introduction of NMESIS (USMC, 2021).

In 2019, the Marine Corps initiated the acquisition of fifth generation ASMs with its authorization to procure $47.6 million in Raytheon-manufactured NSMs (PR Newswire, 2019). The NSM is the world's first fifth generation anti-ship missile, a "long-range precision strike weapon that seeks and destroys enemy ships at a distance greater than 100 nautical miles" (Raytheon, 2021). Originally procured by the Navy to be employed aboard its surface fleet, the missile is designed to elude enemy radar and defense systems through inflight evasive maneuvers while flying at sea-skimming altitudes (Raytheon, 2021). As a land-based system, the NSM has successfully executed testing from ground-based launchers, displaying the ability to climb and descend terrain enroute to its intended target (Raytheon, 2021). This attack method limits an enemy's ability to detect and intercept missiles while in flight. The Marine Corps designation for this land-based system is the Ground Based Anti-Ship Missile (GBASM) concept.

With the introduction of the GBASM concept, the Marine Corps must look at new manning and equipping challenges that accompany major structural redesigns (USMC, 2021). This new system, designated as ROGUE-Fires, is one part of the larger operational concept that makes up the NMESIS (SYSCOM, 2021). ROGUE-Fires will facilitate this joint concept by striking at enemy surface ships from Expeditionary Advance Bases within the enemy's WEZ, affording the Navy operational maneuver space, and allowing amphibious forces to position surface connectors within launch distances to conduct amphibious assaults. Figure 1 is an example of a potential adversary's ability to conduct coastal defense.

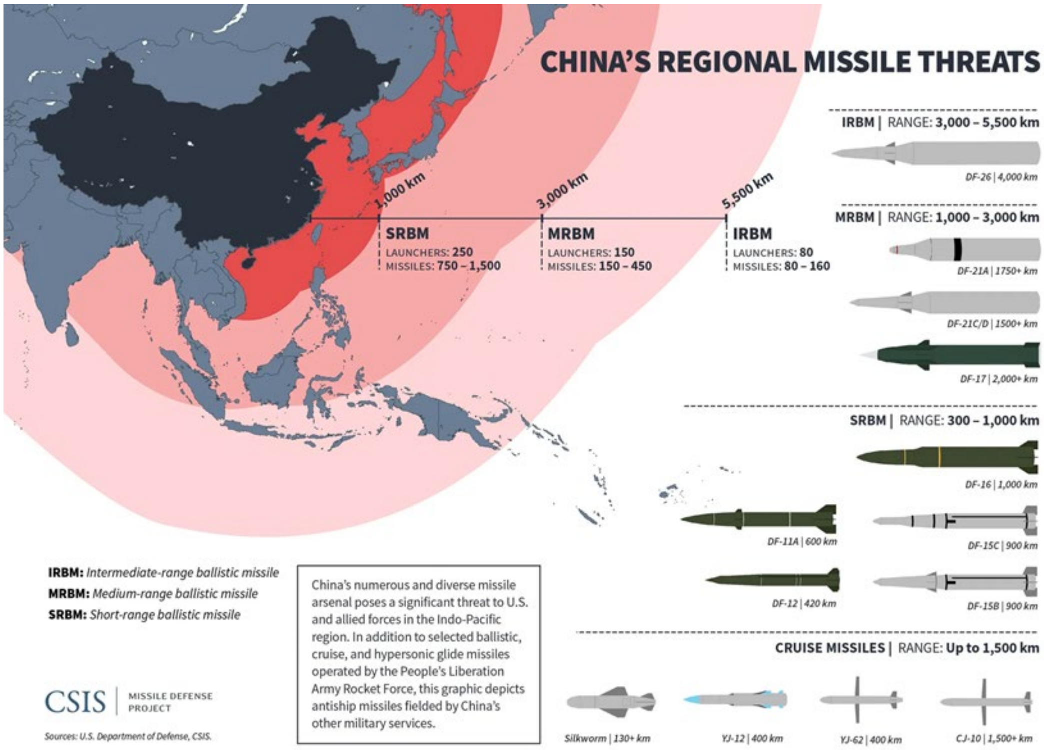

Figure 1. Example of a Potential Adversary A2AD Capability. Source: CSIS Missile Defense Project (2022).

The Marine Corps employment concept will be to use an unmanned and networked capability enabling distributed ground-based fires (SYSCOM, 2021). ROGUE-Fires, a remotely operated JLTV mounted with GBASMs, will be deployed within littoral island chains to act as a first strike weapon that will help to negate an adversary's A2AD systems. These unmanned systems will be remotely operated by Marines from repurposed towed artillery batteries that will reorganize and refit to support this new mission (USMC, 2021).

E. SUMMARY

Current strategic guidance has highlighted the need for the DOD to adapt to changing global threats. Advances in technology have closed the gap between our weapon capabilities and those of our potential adversaries. Proliferation of long-range precision strike weapons limit freedom of maneuver within contested littoral areas of operation and threaten disruption of global commerce. The United States and our allies must work together to maintain global access and limit threats from hostile nations. Accomplishing this requires the DOD to reorganize forces to compete in a new threat environment. Joint concepts and integrated systems will enable our forces to focus limited financial resources toward mission accomplishment.

Individual services within the DOD must consider the effects of their acquisition projects upon the joint force. The Marine Corps' decision to replace towed cannon artillery with the NMESIS is one example of an individual service conforming to the joint service concept. By filling a capabilities gap for the joint force, the Marine Corps has accepted the idea that future cannon artillery requirements will be supplemented by the United States Army. This mindset will allow procurement of additional complimentary systems that facilitate joint employment, reducing the DOD budget and ensuring future mission success. In Chapter III, I introduce literature that supports the strategic guidance outlined above and discuss studies that look at the manning of autonomous systems.

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III. LITERATURE REVIEW

The literature review for this study focuses on three topics that aid in scoping the research in the context of military use of unmanned vehicles (UVs). First, policies on the use of both aerial and ground UVs were studied to understand the direction the DOD is pushing military acquisition projects. Pivotal among those policy letters is the 2001 guidance from the Office of the Secretary of Defense reviewed in Section A. Additional literature from the 2010 book by Anthony Finn and Steve Scheding looks at force integration challenges for military organizations. Next, studies on the use of ASMs in militaries across the world are reviewed. Many documents are available detailing the use of ASMs, but the RAND Corporation study outlined in Section B provides not only technical information about the weapon system but uses their research to incorporate a possible real-world scenario in which the system would be employed. To supplement the RAND study, I looked at a study on procurement of ASM by the Australian Defense Forces. The article highlights the role that ASMs are playing in not only offensive amphibious operations but their importance to coastal defense against foreign aggression. To round out the literature review, research on the effects of manning autonomous platforms is studied. The primary source is a 2020 study by two Dutch professors from the Delft University of Technology. Their study focuses on manning of autonomous commercial vessels, but it is useful because it highlights second order effects that are applicable to all unmanned platforms.

A. STUDIES ON UV

The DOD has a long history of employing UVs for various roles at all levels of war. In April of 2001, the Office of the Secretary of Defense published *Unmanned Aerial Vehicles Roadmap 2000–2025* to "stimulate the planning process and to provide a forum of mutual discussion." The intent of their study is to highlight current operational systems, discuss developmental needs for the future, prioritize needs from the Combatant Commanders, and focus service level components toward joint procurement (Office of the Secretary of Defense, 2001). This planning document displayed the DOD's need "for developing and employing unmanned aerial vehicles (UAVs) over the next 25 years (2000 to 2025)" (Office of the Secretary of Defense, 2001). Specifically, Combatant Commanders identify theater threats that they desire UAV technology be applied toward to facilitate mission accomplishment.

The authors use Moore's Law-style analysis to focus on technological growth through 2025, looking at "key areas of propulsion, sensor, data link, and information processing capabilities" (Office of the Secretary of Defense, 2001). The outcome is a planning tool that aligns capability-enhancing technology of current and projected UV projects, with expected operational possibilities. As stated, "it is a map of opportunities, not point designs - a descriptive, not a prescriptive, future for UAVs" (Office of the Secretary of Defense, 2001).

This policy letter is one of the key documents that shifted DOD focus toward unmanned systems and the fielding of the NMESIS. Service Chiefs are directed to consider autonomous technology for all future systems during project development, formally known as the Joint Capabilities Integration and Development System (JCIDS) phase of the Defense Acquisition System. Integration among services and non-DOD technology firms is encouraged to help speed the acquisition process and reduce redundant spending. To facilitate this integration, the DOD introduced the Defense Innovation Unit (DIU) in 2015 to "strengthen our national security by accelerating the adoption of commercial technology throughout the military and growing the national security innovation base" (Defense Innovation Unit, n.d.). Along with the Defense Advanced Research Projects Agency (DARPA), these two agencies look to incorporate advancing technologies from private industry, the private defense sector, and entrepreneurs to increase U.S. national security.

Challenges to the implementations of the DOD guidance must be considered as services seek to meet future needs. The 2010 book *Developments and Challenges for Autonomous Unmanned Vehicles* touches on some of these challenges. In Chapter 5 of the book, the authors focus on force integration of UVs and highlight the skepticism that still resides in military circles today. This skepticism comes from concerns over two main points.

The first is that “benefits of these systems are sometimes stated in terms of replacing soldiers in the force structure, rather than aiding them to perform their missions” (Finn and Scheding, 2010, Chapter 5). Fear of systems replacing manpower on the battlefield, thus reducing total force strength of the DOD, could have disastrous effects if those systems fail and troops are required to conduct warfare in a traditional form. Traditionalists believe that troops on the ground will continue to determine the outcome of victory. The authors argue that military planners should focus integration efforts on supplementing and increasing the efficiency of an individual soldier by using UVs to reduce workload, thus reducing the risk of putting humans in dangerous situations on the battlefield. Before reducing total force size, planners must consider task saturation to remaining troops. People will still be required to conduct many activities that supplement a military operation. Not accounting for supplemental activities in future manpower models will increase the risk associated to operations and negate the advantage of using UVs. This concept directly applies to the NMESIS T&R task for my research. By reducing total force strength in my model, the unit was unable to accomplish basic combat skills associated to internal security and force protection.

A second concern of integration of UVs into military operations is performance decline of military members. The authors point out that “some changes intended to increase performance resulted in performance declines” (Finn and Scheding, 2010, Chapter 5) Again, this can be seen as a manpower and tasking issue. If personnel are recruited and trained to accomplish task that augment a systems capability, will they be unable to perform operational task if required? Simply stated, if a soldier relies on a UV to perform patrolling operations and that UV becomes ineffective, could the soldier pick up a rifle and conduct the same function? Overreliance on technology could result in mission failure. In the 2009 book *Wired for War*, Peter Singer states “In future military conflicts, having a strong bladder and a big butt may turn out to be more useful physical attributes than being able to do a hundred push-ups” (Singer, 2009). Training manpower to become both a system operator and foot soldier will be a tasking issue that Commanders will be forced to reconcile.

Both concerns outlined by Finn and Scheding are important for my research. While developing the T&R task list for a NMESIS battery, task saturation and Marine Corps common skills degradation are a key factor in formulating an optimal equipping solution for the unit. Providing a suboptimal T/E for the battery will result in a unit that is combat ineffective.

B. STUDIES ON LAND BASED ANTI-SHIP MISSILES

Numerous studies have conducted operational effectiveness reviews on legacy weapon systems to assess their ability to increase lethality in a A2AD environment. Countries in Europe, South America, Central Asia, and the Pacific are all currently developing or procuring Land Based Anti-ship Missiles (LBASM) to augment their defensive capabilities against amphibious attack. Within the United States, the RAND Corporation published a 2013 study that highlighted the need for U.S. employment of LBASM within the Western Pacific.

This 2013 RAND study is a detailed look at A2AD possibilities in a hotly contested area of operations. The authors use this area of operations to layout a possible scenario focused on establishing a "far-blockade" of China (Atler et al., 2013, p.3). Their intent is to demonstrate how the U.S. could use ASMs to support regional partners through various supporting or direct-action methods in the region. Their scenario would also allow the U.S. to redirect traditional air and naval assets away from the region while still maintaining operational relevance, providing the DOD with flexibility around the world. The methodology for the study was to conduct a missile-to-missile study on 45 current ASMs employed by countries in the region, using technical data for gauging potential effectiveness in limiting Chinese seaborne capabilities outside the First Island Chain (Atler et al., 2013, p.3).

The recommendations outlined by the authors are like current USMC plans for Force Design 2030. Based on their evaluation of LBASMs, the authors found that reorganizing a force designed to employ ground based long-range precision strike missiles would be the most effective method to counter an adversary's A2AD capabilities while providing the U.S. flexibility to deploy additional forces elsewhere (Atler et al., 2013). One caveat of their conclusion was that the force must employ an integrated joint force concept in which individual services provide specialized units operating within a collaborative employment system. Additional support must come from regional partners and allies to ensure gaps within the "far-blockade" are accounted for.

Current strategic guidance mirrors the authors' recommendations. Within the 2018 NDS, this joint concept is referred to as "Joint Lethality" (DOD, 2018). Joint Lethality is more complex than individual DOD services working toward a common operational picture, it directs integration through "seamless integration of multiple elements of national power-diplomacy, information, economics, finance, intelligence, law enforcement, and military" (DOD, 2018). The NDS also highlights the need for "mutually beneficial alliances and partnerships" that will be crucial to U.S. strategy around the world (DOD, 2018).

The RAND study is important for this study because it provides an operational context in which a NMESIS battery would likely be employed in the future. This context gave me an idea of how a NMESIS battery would operate in a distributed maritime environment within a littoral combat zone. Planners can conceptualize manning and system operator task based off tactical requirements to man, train, and equip the NMESIS battery. Since the USMC has yet to define manning and training requirements for the unit, the RAND study is instrumental in data collection and the formulation of T&R task that were developed to answer the research questions.

In 2016, the Australian government announced a plan to purchase 5 billion dollars' worth of LBASMs over a ten-year period (Raymond, 2018). Justification for the procurement of ASMs was two-fold. ASM systems would help protect the Northwest coast of the country against foreign invasion and it would be used to support ground forces deployed abroad (Raymond, 2018). In 2018, Gregory Raymond published an article in the Asia and Pacific Policy Studies journal discussing the procurement.

Raymond's article is primarily focused on the internal pressures that helped justify the purchase, mainly the military industrial defense industry and the Army's ability to exert more influence within the government. The article also speaks to the ability of allies to exert influence in developing a coalition of interoperable systems to deter aggression in the Western Pacific, mainly the U.S. ability to convince Australia to pursue a strategy of establishing a "far-blockade" of China within the First Island Chain. The concept mirrors the language published in the 2018 NDS and USMC Force Design 2030.

We must consider the importance of coalition partners when looking at procurement projects within the DOD. Due to a shrinking defense budget, recent strategy has sought to fill capability gaps by incorporating allied forces into operational planning (USMC, 2020). Planners should take this into account when determining the capabilities of independent units. The incorporation of joint and coalition forces lessens the burden of organic support, which reduce the requirement for individual units to provide self-sustainment for long duration operations. This is important when considering requirements for NMESIS units as some logistics and support functions will no longer be organic at the tactical level, reducing their manpower and training requirements.

C. STUDIES ON MANNING OF AUTONOMOUS SYSTEMS

Numerous researchers have studied the effects of manning on systems. Often referred to as "workload modeling," researchers have sought to provide an optimal manning solution within civilian and military labor forces. In 2004, working for the Army Research Laboratory, Josephine Wojciechowski wrote a report on the effectiveness of the Army's Improved Performance Research Integration Tool (IMPRINT). This model was used to develop "task and workload associated with driving a ground vehicle" (Wojciechowski, 2004). The intent was to test mental processing, attention, and response time while the driver was simultaneously tasked with additional requirements. This example of studying human performance is one of many that have been conducted to determine optimal workload for people in varying environments. Task saturation concerns are accounted for in the Training Effectiveness Evaluation Plan (TEEP) for a NMESIS battery.

While research on optimization of manned systems has been extensive, the same cannot be said of unmanned systems. Many studies on unmanned systems have focused on system integration into current work environments, with an emphasis on potential increases in efficiency, but few have looked at the effects of automation on crew size (Karla, 2016). Dutch professors, Carmen Kooij and Robert Hekkenberg considered this in their 2020 research on manning autonomous shipping vessels.

Kooij and Hekkenberg developed a "crew analysis algorithm" to provide the "cheapest crew composition" that could accomplish required task aboard shipping vessels (Kooij & Hekkenberg, 2021). As mentioned by the authors, naval crew members are unlike ground transportation operators in that they are also required to perform additional task while assigned to the ship. This caused the researchers to first identify all possible required task of a crewmember, consider what task could be automated based on current technology, and model a solution to reduce crew size based on remaining task. Using their model, the authors were able to provide an optimal manning solution for the shipping community but also cautioned readers that a minor requirement to conduct additional crew task could significantly change the outcome. Their identification of potential risk tied to reducing crew sizes due to automation should be considered by managers before being applied.

The importance of this study is evident while considering the automation of military weapons platforms, especially in the assignment of task. This consideration is an important aspect while developing the T&R manual for the NMESIS battery, the major input within my sensitive analysis. While identifying all secondary or tertiary task of a military member would be difficult, we must consider the loss of unit operational capability when contemplating reducing manpower for units manning autonomous systems. Basic military requirements such as local security patrols, maintenance and logistics support, and surge operations will require units that operate unmanned systems to maintain a level of manpower greater than that required to remotely operate the weapon. The acceptable level of risk associated to the manpower level of these units could have lethal consequences as they operate within a distributed maritime environment.

D. SUMMARY

Understanding the DOD policy and associated research on unmanned systems is critical for my research. Concerns over task saturation, degradation of operator skills, and risk management are accounted for in the TEEP within Chapter IV. Recognizing the dynamics of individual proficiency as opposed to crew proficiency is important for future leaders seeking to develop effective training plans. Providing the adequate number of systems for those individuals to accomplish individual proficiency must be considered as services procure, fund, and source future weapons. Failure to produce effective individual operators will affect mission accomplishment in the future, as team members can no longer account for the deficiencies of their peers.

IV. DATA AND METHODOLOGY

This study is an attempt to provide Marine Corps planners with an optimal equipping solution for a NMESIS battery based on the time it would take individual operators to accomplish their T&R requirements. Since the T&R manual for the NMESIS battery has yet to be published, I developed a set of 70 requirements to represent individual level T&R tasks. Referred to in the Marine Corps as 1000 and 2000 level tasks, I took these requirements from current T&R manuals of 'like systems.' After compiling the task list, training times are associated to each individual task which I used to design a simple algorithm to compute total training time per Marine. I converted training time into the annual training time per Marine, accounting for the frequency at which each task must be completed: monthly, quarterly, or annually. I used the annual training time per Marine to calculate the total unit training time based on three separate proposed manning templates. The last step in my methodology is to compute the average training time per unit using four separate T/E proposals: 8 systems per unit, 12 systems per unit, 16 systems per unit, and 18 systems per unit. The recommendations provide an answer to how many systems are needed to complete readiness requirements. Planners can use this information to compare the recommendation against proposals to equip based on budgetary constraints. This will provide USMC decision makers with a realistic outlook for future NMESIS unit readiness based on T/E.

A. TRAINING AND READINESS EXPLANATION

To understand the basis of the 70 requirements that I developed as T&R tasks, we must understand the Marine Corps T&R program. This program is the Marine Corps' "primary tool for planning, conducting, and evaluating training, and assessing training readiness" (TECOM, 2018). Published by the Commander of Training and Education Command (TECOM) in Quantico, each community within the Marine Corps assigns senior members of each Military Occupational Specialty (MOS) to develop their manual. These subject matter experts (SME) assign organic requirements called Mission Essential Task List (METL), which are derived from a consolidated Marine Corps task list (TECOM, 2018). Assignment of METLs is based on the community's requirement to provide overarching Total Force operational capabilities, such as Provide Task-Organized Forces, Support Amphibious Operations, Conduct Ground Delivered Fires, etc (TECOM, 2018). METLs, along with Marine Corps Task (MCT), are used as the "common standard for all units to derive training requirements from and must be accomplished by all units within that community" (TECOM, 2018). All individual and collective training events contained in the manual relate directly to these METLs and MCTs. A comprehensive T&R program ensures individual units conduct efficient training that facilitates a common understanding of MOS requirements. Ultimately, the intent is to ensure each unit within an MOS can accomplish real-world missions.

Table 2. Example of a Marine Corps Regimental Mission Essential Task List. Source: Marine Corps, Training and Education Command (2018).

ARTILLERY REGIMENT CORE MARINE ESSENTIAL TASK (METs)	
MCT 1.1.2	Provide Task-Organized Forces
MCT 1.1.2.3	Provide Headquarters Personnel and Infrastructure
MCT 1.12.2	Support Amphibious Operations
MCT 3.1.3.2	Identify Target Acquisition (TA) Taskings
MCT 3.2.1	Conduct Fire Support Tasks
MCT 3.2.1.3	Integrate Fire Support with the Scheme of Maneuver
MCT 3.2.4	Conduct Ground Delivered Fires
MCT 3.2.4.2	Conduct Indirect Fires
MCT 3.2.4.3	Conduct Counterfire Operations
MCT 3.2.4.5	Conduct Sensor Operations
MCT 5	Exercise Command and Control

Within the T&R Manual, collective and individual training requirements are assigned to facilitate combat readiness. Using a numeric system, task known as 'individual task' are labeled as 1000 or 2000 level task, meaning all Marines with the designated MOS and grade are required to accomplish them (TECOM, 2018). Level 3000, 4000, 5000, and 6000 task are known as 'collective task' and must be accomplished by differing echelons of the force structure: squad, platoon, company, battalion, etc (TECOM, 2018). The manual is not intended to be an all-encompassing document that dictates all training requirements, instead it "identifies the minimum standards that Marines must be able to perform in combat" (TECOM, 2018). Ultimately, the manual is a reference to help commanders meet pre-deployment training objectives and track unit readiness across the force (TECOM, 2018).

One of the most important aspects of the T&R program is evaluation. Leaders are expected to evaluate the proficiency of all MOSs and assigned billets within their units. Commanders are responsible for recording the training events for individual Marines. Leaders are responsible to ensure all Marines display proficiency at or before the designated expiration of a sustainment interval; monthly, quarterly, or annually based on the event (TECOM, 2018). Evaluators can either be organic to the unit or sourced from adjacent commands. Typically, evaluations are done during collective training or service level exercises (TECOM, 2018). Informal evaluations can be accomplished during daily operations and training schedules. Formal evaluations are "often scenario based, focused on the unit's METs, based on collective training standards, and usually conducted during higher level training exercises" (TECOM, 2018).

To ensure standardization of the evaluation process, event requirements are outlined through an evaluation card. Within the card, the event criteria are explained by showing the who, what, when, and how of the task to be evaluated. Table 3 is an example of an individual training event taken from a current T&R manual. The table provides unit leaders and event evaluators with all the information required to ensure a standardized approach to task completion. It also provides leaders with the references that should be utilized to train participants in the completion of each task.

Table 3. Example of an Individual Training Event Evaluation Card. Source: Marine Corps, Training and Education Command (2019).

3537-ADMN-2001: Manage tool control	
EVALUATION-CODED: NO	**SUSTAINMENT INTERVAL**: 12 months
READINESS-CODED: NO	
MOS PERFORMING: 3537	
GRADES: SSGT, GYSGT, MSGT, MGYSGT	
INITIAL TRAINING SETTING: MOJT	
CONDITION: Given references a requirement, tool sets, chests, and kits,	
Automated Information System (AIS), forms and records, and references.	
STANDARD: To ensure accurate accountability and serviceability.	
PERFORMANCE STEPS:	
1. Identify authorized tool sets, chests, and kits.	
2. Enforce inventory procedures.	
3. Inspect inventory records.	
4. Validate tool sets, chests, and kits requisitions.	
5. Determine control methods.	
6. Enforce tool disposition procedures.	
REFERENCES:	
1. AETM Applicable Equipment Technical Manuals	
2. AIETM Applicable Interactive Electronic Technical Manual	
3. ASL-3 Applicable Stock Listing	
4. MCO 4400.150 Consumer-Level Supply Policy	
5. MCTP 8-10B How to Conduct Training	

Evaluation of individual level task are important for unit readiness reporting. Although units are not required to report completion of individual tasks, they facilitate the completion of collective tasks that are reported through the Defense Readiness Reporting System (DRRS). Collective events are the capabilities that a unit must be able to perform. Known as Evaluation-Coded (E-Coded) events, completion of these task must be reported monthly by battalion sized units and higher (TECOM, 2018). The DRRS report gives operational planners up-to-date information on the status of the most combat ready units available for contingency deployments.

Another training requirement that unit leaders must factor into their training plans are ‘common to all’ tasks. Common to all tasks are requirements that must be completed to be considered operationally deployable, regardless of MOS. Such tasks include conducting first aid, executing a Medical Evacuation (MEDAVAC), and conducting a forced march while carrying a combat load. These requirements are important when considering a unit’s training cycle as they are all time-consuming events that require repetition to become proficient.

For my study, I focus on the individual level tasks of a NMESIS battery, the 1000 and 2000 level events. As stated in the opening of every MOS T&R Manual, “Individual training and the mastery of individual core skills serve as the building blocks for unit combat readiness. A Marine’s ability to perform critical skills required in combat is essential” (TECOM, 2018). These individual tasks are also the most time consuming for the unit, as accomplishment requires the use of shared equipment and individual evaluations that must be tested on a monthly, quarterly, or annual basis.

B. DATA SOURCES

I used three primary sources to identify task that will be required of a NMESIS battery. The first is the Artillery T&R Manual, specifically the section pertaining to a HIMARs unit. Next, the Motor Transportation T&R Manual is used to identify incidental operator task that are required for all ground combat vehicles in the Marine Corps inventory. The third source is the Small Unmanned Aircraft Systems T&R Manual. This source provided tasks associated to system checks, startup procedures, and launch criteria of unmanned systems. Training times used to compute total training time are associated to these 70 tasks based on current standards from like systems.

1. Navy and Marine Corps (NAVMC) Publication 3500.7C: *Artillery Training and Readiness Manual*

The Artillery T&R Manual is the primary training source for all artillery units. Individual chapters are dedicated to the training of artillery officers, target acquisition officers, cannon crewman, HIMARs crewman, radar operators, fire controlmen, sensor support personnel, operation chiefs, and fire support personnel. I used 23 individual HIMARs task associated to setup and employment to formulate requirements for the NMESIS battery. The 23 requirements, training interval, and training time per Marine are listed in Table 4.

Table 4. NMESIS Individual T&R Tasks. Adapted from Marine Corps, Training and Education Command (2018).

Event Title	Training Interval	Training Time
Operate the vehicle mounted radio	Quarterly	20 mins per
Operate vehicle intercomm system	Quarterly	20 mins per
Troubleshoot digital communications	Monthly	10 mins per
Perform preventive maintenance on launcher chassis	Quarterly	60 mins per
Prepare Weapons Control System (WCS)	Quarterly	10 mins per
Operate the Universal Fire Control System (UFCS)	Quarterly	20 mins per
Record missions fired	Quarterly	10 mins per
Prepare re-supply system for transportation of ammunition	Quarterly	30 mins per
Conduct reload operations	Quarterly	20 mins per
Prepare NMESIS for C-130 transport	Monthly	30 mins per
Conduct operations of the UFCS	Quarterly	10 mins per
Load cryptographic keys	Quarterly	10 mins per

Event Title	Training Interval	Training Time
Process masking data	Quarterly	10 mins per
Compute safety	Quarterly	30 mins per
Utilize a Range Safety-T	Quarterly	10 mins per
Execution a digital fire mission	Quarterly	20 mins per
Supervise misfire and hang-fire procedures	Quarterly	10 mins per
Conduct reload operations	Quarterly	20 mins per
Conduct local security operations	Quarterly	30 mins per
Conduct a tactical road march	Quarterly	60 mins per
Conduct battery defense	Quarterly	60 mins per
Conduct operations in the position area	Quarterly	60 mins per
Supervise operator level maintenance	Quarterly	60 mins per

2. Navy and Marine Corps (NAVMC) 3500.39D: *Motor Transport Training and Readiness Manual*

The Motor Transport T&R Manual provides training requirements for all ground vehicular operations. Minimum requirements include operating under various terrain and environmental conditions. I incorporated 33 tasks that include incidental operator and MOS specific task. Incidental operator task are requirements for all licensed vehicle operators, regardless of MOS. MOS specific task only relate to Motor Transportation designated personnel. Both will be required for the employment of a NMESIS battery.

Table 5. NMESIS Individual T&R Tasks. Adapted from Marine Corps, Training and Education Command (2019).

Event Title	Training Interval	Training Time
Perform Preventive Maintenance Checks and Services (PMCS)	Yearly	30 mins per
Maintain vehicle auxiliary systems on motor transport equipment	Yearly	30 mins per
Transport hazardous/explosive cargo	Monthly	40 mins per
Conduct refueling operations	Monthly	30 mins per
Prepare equipment for movement through available nodes	Monthly	30 mins per
Conduct vehicle self-recovery operations	Monthly	60 mins per
Perform fording operations	Monthly	30 mins per
Conduct Battle Damage Assessment and Repair (BDAR)	Monthly	30 mins per
Operate a tactical vehicle in restricted spaces	Monthly	30 mins per
Operate a tactical vehicle in CBRN environment	Monthly	30 mins per
Operate the automotive systems and components of a JLTV	Monthly	30 mins per
Operate a JLTV during night operations	Monthly	30 mins per
Change tire on a JLTV	Monthly	30 mins per
Operate a JLTV in urban, jungle, and restricted areas	Monthly	30 mins per
Operate a JLTV off road over rough and uneven terrain (L/S)	Monthly	30 mins per
Conduct recovery of disabled JLTV	Monthly	30 mins per

Event Title	Training Interval	Training Time
Drive a JLTV over soft surfaces terrain and roads (L/S)	Monthly	30 mins per
Operate a JLTV on varying grades and side slopes	Monthly	30 mins per
Conduct emergency egress procedures in a JLTV	Monthly	30 mins per
Operate a JLTV in arctic {snow and ice} conditions	Monthly	30 mins per
Operate a JLTV while towing a light tactical trailer (S/L)	Monthly	30 mins per
Operate a JLTV in convoy (L/S)	Monthly	30 mins per
Execute a load plan for a JLTV	Monthly	30 mins per
Camouflage a JLTV	Monthly	30 mins per
Drive a JLTV utilizing vision enhancement devices	Monthly	30 mins per
Recognize indicators of Improvised Explosive Devices (IED)	Monthly	10 mins per
Confirm the presence of an IED	Monthly	10 mins per
React to a HME threat	Monthly	10 mins per
React to an unexploded IED	Monthly	10 mins per
React to an IED attack	Monthly	10 mins per
Plan for movement in environments with an IED threat	Monthly	10 mins per
Negotiate IED Danger Area	Monthly	10 mins per
Operate Counter Radio Controlled IED (RCIED)	Monthly	10 mins per

3. Navy and Marine Corps (NAVMC) 3500.107C: *Small Unmanned Aerial Systems Training and Readiness Manual*

I used 14 tasks derived from NAVMC 3500.107C that include requirements for the setup and employment of unmanned systems. Basic operator tasks including troubleshooting digital communications, relay operations, and remote navigation will be critical for the employment of all future unmanned systems. These tasks will continue to be refined through the Production and Deployment phase of this current acquisition project.

Table 6. NMESIS Individual T&R Tasks. Adapted from Marine Corps, Training and Education Command (2020).

Event Title	**Training Interval**	**Training Time**
Knowledge of specific system description	Yearly	10 mins per
Knowledge of controls and indicators.	Yearly	10 mins per
Precombat checks & launch	Yearly	30 mins per
Employment & recovery	Yearly	30 mins per
Perform system maintenance and troubleshooting	Yearly	30 mins per
Understand system specific emergency procedures	Yearly	10 mins per
Prohibited Activities	Yearly	10 mins per
Hand off procedures	Yearly	10 mins per
Night operations	Yearly	30 mins per
Single operator with assistant	Yearly	30 mins per
Incident reporting	Yearly	10 mins per
Remote operations	Yearly	20 mins per
Relay operations	Yearly	10 mins per
Operate range and bearing tool	Yearly	10 mins per

The requirements listed above make up the MOS specific tasks that I used to compute total training time for a NMESIS battery. Refinements to this list will likely occur as designed test units conduct fielding and employment validation.

C. CALCULATIONS OF NMESIS INDIVIDUAL T&R TASK TRAINING TIME

Using the 70 requirements outlined above, I calculated total training times. First, individual training time in minutes is calculated by multiplying event times by the frequency that event is required to be completed within an annual period. This totaled 12,830 minutes or 213.8 hours per Marine on an annual basis.

Individual Training Time (mins) = Event time x Frequency = 12,830 mins or 213.8 hrs

As previously mentioned, Marine Corps planners have yet to finalize the NMESIS battery manning and equipment tables. Initial planning factors include a force structure based on two platoons of three sections, manned by a force equivalent to the current HIMARs table of organization (Total Force Management System [TFMS], 2021). Each section would comprise three launchers for a total of 18 systems per battery (SYSCOM, 2021). Budgetary constraints will play a significant role in final force size, both in terms of systems and Marines per unit. To account for the uncertainty in force size, I calculated training time per unit with four independent equipment and manning tables.

Training time per equipment table (hrs) = Individual Training Time (hrs) x Force Size / Number of systems per unit

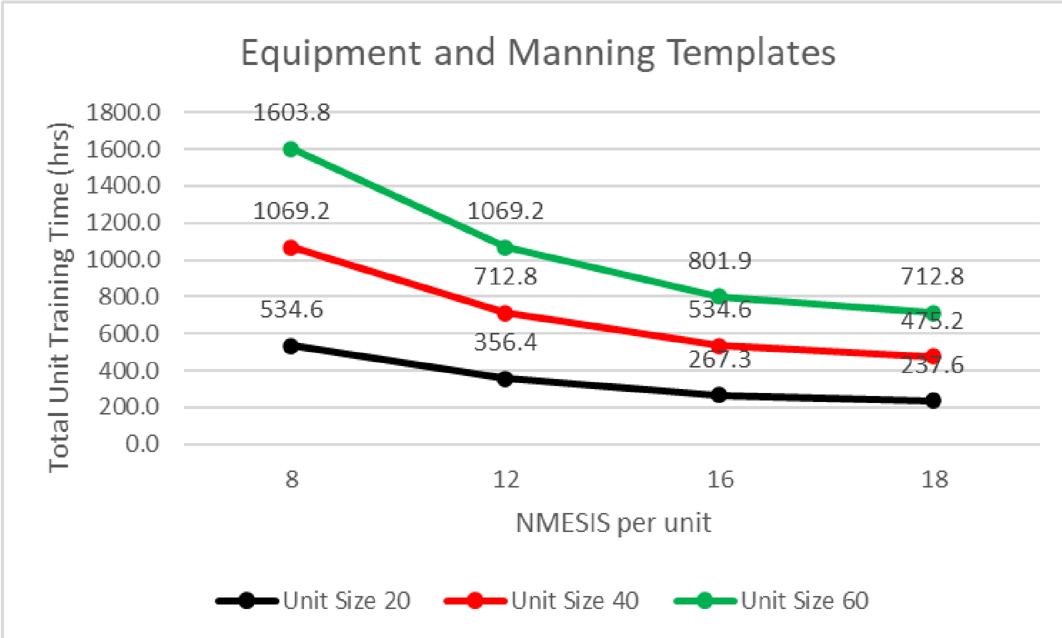

Figure 2. Required Hours to Complete Training for Separate Manning and Equipping Templates.

Analyzing Figure 2 shows a significant reduction in total unit training time as manning templates are reduced and weapon systems are increased. To further codify total unit training time, I templated my calculation by aligning it to a standard unit Training Exercise and Employment Plan (TEEP). Organizational planners will vary their methods for formulating a TEEP, but it is based on the forty-hour work week model as directed within the Marine Corps *Unit Training Management Guide* (Marine Corps Training Publication 8–10A, 2016). Field exercises allow the commander to exceed the forty-hour work week model if risk assessments account for a safe training environment. The table below shows workdays required to complete a unit's individual T&R tasks.

Workdays to Complete T&R tasks = Total Unit Training Time (hrs) / 8

Table 7. Workdays Required to Complete 1000/2000 Level T&R Tasks.

Unit Size	# of ROGUE-Fires Systems	Workdays to complete
20 Marine	8	67
	12	45
	16	34
	18	30
40 Marine	8	134
	12	90
	16	67
	18	60
60 Marine	8	201
	12	134
	16	101
	18	90

Note: Days are rounded up to whole numbers.

Understanding the time requirements for individual level training task are the starting point to provide a recommendation for an optimal equipping solution. Additional requirements that include common to all T&R tasks, Marine Corps Total Force Training requirements, and service level training events must be considered. In section D, I developed a notional unit TEEP to capture all requirements and provide better understanding of available unit training time.

D. ADDITIONAL TRAINING CONSIDERATIONS

MOS specific training requirements make up a portion of a unit's training capacity. Leaders must dedicate time to ensure maintenance, service level training objectives, and Total Force requirements are incorporated into their plans. These considerations play a significant role in total unit training time.

1. Maintenance

Marine Corps maintenance requirements are broken down into echelons of care. For this research, the two lowest tiers of maintenance are discussed as they require unit personnel to complete. One reason for the tier system is to account for the limited amount of personnel within each unit's T/O. A battery sized element is allotted eight vehicular mechanics, three weapons technicians, and three small arms repairmen (TFMS, 2021). Their primary role is to conduct second echelon maintenance, repairs that require school trained Marines with specialized skills. First echelon maintenance is conducted by non-mechanics. These tasks are often referred to as preventative maintenance. To effectively maintain a unit's gearset and help prevent major repairs, a battery conducts preventative maintenance on a weekly basis. Actions include changing tires, replacing fluids, and cleanliness to negate potential corrosion issues. Due to the amount of equipment assigned to the battery, these actions typically take one full workday and include all assigned personnel within the unit.

2. Total Force Requirements / Common to All Tasks

The primary document that outlines annual non-MOS training requirements is Marine Corps Order (MCO) 1500.63. This reference is a "comprehensive listing of mandatory individual Training and Education requirements" (USMC, 2021). Events in this order are organized into core and non-core requirements. Core requirements "directly support warfighting and unit mission tasks" while non-core requirements are "non-occupational tasks that provide common knowledge and awareness" while reinforcing standards of conduct (USMC, 2021). Required training is listed in Table 8.

Table 8. Total Force Training Requirements. Source: United States Marine Corps (2021).

Water Survival Training
Chemical, Biological, Radiological, and Nuclear Defense Training (CBRN)
Rifle Marksmanship Training
Pistol Marksmanship Training
Physical Fitness Program
Anti-terrorism Awareness Training
Counterintelligence Awareness and Reporting
Prohibited Activities and Conduct Prevention and Response (PAC)
Cyber Awareness
Risk Management
Unit Marine Awareness and Prevention Integrated Training (UMAPIT)
Sexual Assault Prevention and Response (SAPR)
Operational Security (OPSEC)
Records Management

Accomplishing these training events requires units to conduct both internal periods of instruction and scheduled events through non-organic training entities. Due to limitations within infrastructure and range facilities, units are required to conduct multiple evolutions of this training as subgroups. Most training events require support personnel to facilitate transportation, provide range safety and medivac capabilities, or to act as trainers. The result is a reduction in the unit's ability to conduct concurrent task accomplishment.

Common to all tasks are requirements that all Marines are expected to perform. They account for basic combat skills of patrolling, lifesaving, and combat conditioning. These skills are important to the Marine ethos of "every Marine is a rifleman." Basic combat skills establish the mentality that no matter your day-to-day responsibilities, all should be ready to pick up a rifle and execute combat operations. Commanders must incorporate this training regularly, as these skills are time consuming to master. Basic skills are listed in Table 9.

Table 9. Common to all tasks. Adapted from Marine Corps, Training and Education Command (2018).

Machine gun employment
Forced march under combat load
Patrolling
Execution of a medical evacuation
Basic lifesaving skills
Small arms employment
Land Navigation

Failure to effectively implement common to all tasks into training plans could have catastrophic consequences. Limited force structure within the Marine Corps requires all individuals to possess the ability to conduct combat actions.

3. Service Level Training Events

T&R tasks are the responsibility of all echelons of command. While this research focuses on 1000 and 2000 level task completion, we must consider the impacts of higher headquarters training completion on their subordinate units. For battalions, regiments, and divisions to achieve evaluated T&R completion, they must employ subordinate units in tactical training scenarios. This requires multiple higher headquarters level training evolutions throughout the year. Examples of such exercises are Steel Knight, Iron Fist, Summer/Winter Fury, Weapons and Tactics Instructor (WTI) Course, and Integrated Training Exercises (ITXs). Artillery units designated to support these exercises will include all batteries not currently in their deployment training cycle. Historically, artillery batteries could expect to be tasked with supporting at least three of these events on an annual basis.

E. TOTAL UNIT TRAINING TIME

Incorporating all requirements into a standardized TEEP format, we gain a better understanding of time limitations that will inhabit a commander's ability to complete T&R requirements. Using historical data from the 1st Marine Division's training plan as a guide, a notional TEEP is developed to depict a unit's available training time given their obligation to complete all requirements outlined throughout this chapter. Figure 3 depicts days dedicated to specific events within the annual training plan.

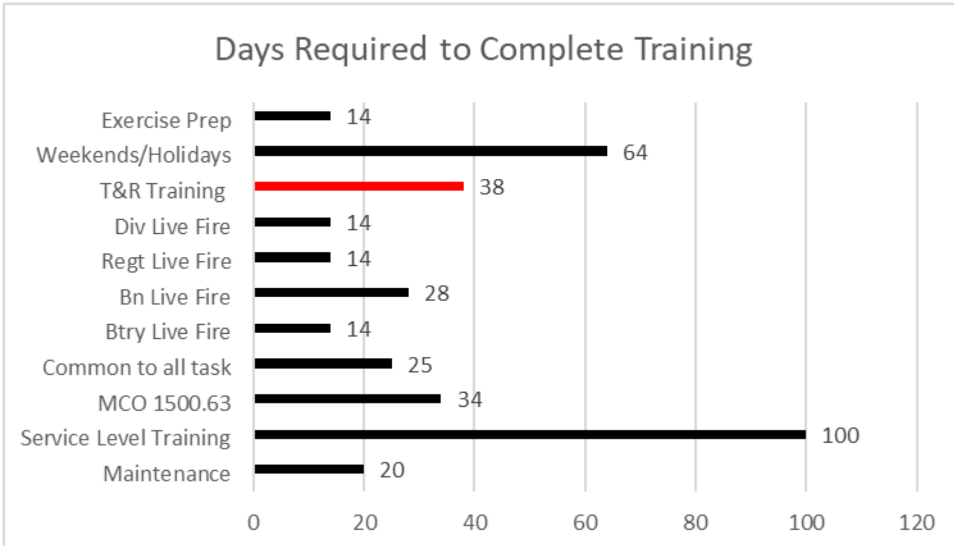

Figure 3. Days to Complete Training for a Marine Corps Artillery Battery.

Within a standard year, there are 260 working days. Figure 3 accounts for 301 working days, as many exercises will include weekends and federal holiday periods. Under favorable conditions, a battery could expect to focus effort on accomplishing T&R training on 38 days annually. My calculation of 38 training days is used to compare the feasibility of completing individual level training, considering the four manning and equipment tables described within this chapter.

F. DETERMINING A RECOMMENDATION

By using my calculations on workdays required to complete T&R training (Table 7) and aligning them to a notional TEEP (Figure 3), I was able to determine a mathematical recommendation for equipping a NMESIS battery. The optimal manning and equipment table to allow for completion of T&R tasks is 20 artillerymen equipped with 16 ROGUE-Fires systems. A unit of this size could complete required training within 34 days, as depicted in Table 7 on page 36. This solution is problematic and not recommended due to the associated requirements the unit must accomplish to be combat effective. Organic capabilities of sustainment, support, and force protection would be non-existent. This left me with two manning solutions, the 40-man or 60-man table of organization.

To determine my recommendation, I first considered the organic task a battery must complete to be combat effective. Such considerations are internal security, the ability to sustain the unit, and the ability to conduct continuous fire support.

1. Historically, artillery units provided their own internal security both on vehicular movements and within the firing position. Machine gun positions provide interlocking fields of fire to protect against enemy attack and local security patrols are used to cover enemy avenues of approach. Marines are trained to perform such actions through the incorporation of basic combat skills training into the unit TEEP. Organic capabilities to perform these tasks require added personnel.

2. Unit maintenance is vital to maintaining the combat readiness of the unit. First echelon maintenance is conducted both in training and garrison environments. Maintenance requirements are labor intensive due to the amount of equipment associated to a battery. Vehicles, small arms, machine guns, primary weapons, and communications equipment require care. The ability to conduct these actions will sustain a unit's combat capabilities and increase their lethality.

3. The battery's ability to provide continuous fire support is crucial to maintain momentum for the ground scheme of maneuver. Artillery response must be always available, throughout the duration of an operation. This requires alternating personnel through sleep rotations, local security, and manning of artillery systems. Redundant operators must be trained to accomplish this task.

Another consideration was to look at the ability to conduct concurrent training. Commanders must have the ability to evaluate individual operators during service level training exercises. This will provide flexibility within the training schedule but does have associated risk. Commanders are evaluated during large scale exercises not only on their ability to employ their battery in a tactical scenario but on the proficiency of their subordinates. Some commanders may be hesitant to rotate senior operators during these events, but it will be important to accomplish all required individual training requirements. Leaders must accept periods of degraded unit performance during large scale events to meet combat readiness goals.

The last consideration was cost. While not the focal point of my research, acquisition cost will be a primary driver of the Marine Corps' sourcing decision. Outlined below is a brief overview of the cost associated to the four equipment tables I used in my analysis. These numbers are just procurement related and further research should be done to account for total life-cycle cost for each equipment table. According to Research and Development Project Cost Analysis, procurement cost per system is $2.1 million (Office of Management and Budget, 2019).

- 16 systems = $33.6 million per battery
- 14 systems = $29.4 million per battery
- 12 systems = $25.2 million per battery
- 8 systems = $16.8 million per battery

The Marine Corps' initial fielding plan is to repurpose 14 cannon artillery units into NMESIS artillery units (Senate Armed Services Committee, 2020). According to the fiscal year 2022 budget request, the Marine Corps is seeking $47.9 billion to overhaul the force for littoral operations (Department of Defense [DOD], 2021). Given that the NMESIS is one of many new systems the Marine Corps is looking to adopt, budgetary constraints will play a major role in meeting T/E goals.

My recommendation, outlined in Chapter V, uses the above criteria to provide a solution that allows a unit to accomplish their training requirements while considering the secondary effects of reduced manning on combat effectiveness, a willingness to accept risk, and the acquisition cost associated to each equipment table.

G. SUMMARY

The implementation of an effective training plan will be crucial for NMESIS battery commanders as they attempt to meet all required training requirements. Unlike their cannon artillery predecessors, NMESIS commanders must consider equipment availability to train individual operators vice teams of Marines. Historically, cannon artillery units worked in teams of eight as howitzer crews. This enabled crews to be evaluated at the individual task level in conjunction with higher echelon training events. Time was saved by completing concurrent task. ROGUE-Fires is a one-to-one system, meaning one individual operates one system. Small unit commanders will be hesitant to rotate inexperienced operators into higher level training scenarios over fears of being reprimanded for poor performance. This could result in over utilization of experienced individual operators and cause a proficiency gap for inexperienced personnel relegated to performing security and support functions. Developing the individual operator will enable the unit to operate effectively in a complex littoral combat area, where the unit will be dispersed across multiple Expeditionary Advanced Bases.

To accomplish all individual level training objectives, the commander will be afforded approximately 38 days annually within the TEEP. They must maximize every training opportunity and be willing to accept risk within service level training events by rotating their senior operators for less experienced Marines. Higher level commanders must accept failure at the battery level to afford battery commanders the opportunity to rotate operators without fear of reprisal.

V. CONCLUSION

The purpose of my study is to recommend an equipping solution for the fielding of the ROGUE-Fires system for a NMESIS battery. Considerations for my recommendation are based on Marine Corps Total Force requirements, MOS specific training requirements, basic combat skills requirements, organic support capabilities, and cost. The intent of the research is to limit task saturation of the battery that will lead to an inability to meet mission readiness standards while also considering financial constraints of excessive equipment and personnel. This will be important for equipping future unmanned systems as individual operators replace crews of Marines in employing other ground combat systems.

To complete my study, I answer three important questions. First, what are the individual level T&R tasks that ROGUE-Fires operators will be required to complete? After reviewing requirements of current missile systems and other remotely operated unmanned systems within the Marine Corps, I developed a set of 70 individual level T&R task. After associating individual training time to each task, I used this task list as the basis to calculate total training time for the unit. That enabled me to calculate the days required to complete T&R training per each of the four equipment tables I used in the study.

My second research was what are the additional training requirements that would limit the battery's ability to complete T&R training? Additional training includes Total Force training requirements, common to all T&R task, basic combat skills training, and service level training exercises. Using a standard TEEP format and historical data from 1st Marine Division units, I formulated an annual training plan to capture all required training. Analyzing the TEEP allowed me to determine that a NMESIS battery will have approximately 38 days to focus on training individual level skills. I was then able to use Table 7 on page 36 to determine the feasibility of completing training based on the four manning and equipment tables used in the research.

Answering the first two research questions allowed me to determine a recommendation for sourcing personnel and equipment for the NMESIS battery, the final question I sought to answer in my research. My recommendation is outlined below, Section

A of this chapter. Factors that helped determine my recommendation were the ability to complete T&R training while maintaining organic support and sustainment capabilities, internal force protection, continuous fire support, and the procurement cost of equipping a battery.

My results are based on current available training requirements of like systems. Assumptions were made that the NMESIS battery's training requirements would mirror these systems as organic training objectives are not finalized. Refinements to the tasks associated with manning and equipping the NMESIS battery should be considered while designated units continue to work through the fielding and testing phase of this acquisition project.

A. RECOMMENDATION FOR EQUIPPING THE NMESIS BATTERY

As outlined in Chapter IV, a NMESIS battery will have approximately 38 days to complete individual level training objectives. Variation in training days available will be based on higher level tasking to complete service level training exercises, the most time-consuming events within a unit's TEEP. Service level training events are important to combined arms execution which is the basis of Marine Corps operational doctrine. Calculation of the 38 training days is based on artillery unit TEEPs from the 1st Marine Division over the last five years.

As seen in Table 7 (page 36), the only manpower and equipment template that would allow for the completion of T&R training is a battery of 20 artillerymen sourced with either 16 or 18 ROGUE-Fires systems. Secondary effects of this manning scenario reside within the associated task of employing a combat unit. First, force protection requirements such as battery defense and local security patrolling would require support from external combat units that will likely be employed elsewhere. Second, self-sustainment would no longer be attainable, requiring additional support from logistics units attached to higher headquarters. Third, operations that require continuous fire support for extended durations would not be feasible for a unit of 20, as battle fatigue would overwhelm the unit and make them combat ineffective. Lastly, the manpower required to conduct first and second echelon maintenance would not be organic to the battery. Based on these issues, I do not recommend pursuing a T/O of 20 artillerymen.

Current manning proposals for the NMESIS battery are aligned to the HIMARs T/O which includes 60 artillerymen per unit (TFMS, 2021). Organic abilities to provide internal force protection and self-sustainment capabilities would be maintained. The issue is a unit of this size is unable to complete required training objectives. Using the largest and most unlikely sourcing solution of 18 systems, the unit would require 90 training days to complete individual level task. Procurement cost to equip 14 NMESIS batteries across the Marine Corps would exceed budgetary allotments for both equipment and personnel. Using the more conservative estimate of 12 systems per unit, a 60-man battery would require 134 days to complete training. This is over three times the allotted time for individual level training, resulting in combat readiness percentages below acceptable levels for combat effectiveness.

My recommendation is that the Marine Corps employs 40 artillerymen per battery, equipped with 16 ROGUE-Fires systems. This will provide the unit with three trained operators per system within a battery. To complete training, 67 days will be required for individual level T&R tasks. Battery commanders can mitigate that requirement through evaluation of senior operators during service level exercises. Procurement cost would be reduced by $4 million per battery, saving the Marine Corps $56 million. Personnel cost will also be reduced, helping the Marine Corps meet its manpower reduction goals outlined in Force Design 2030 (USMC, 2020). Tasks associated to force protection and self-sustainment could still be accomplished organically. Continuous fire support would be based on Marines operating the system on eight-hour shifts, then rotating between local security and rest time.

Risk mitigation will be required for any of the scenarios outlined above. Commanders will need to consider task saturation as they formulate their training plans. Unforeseen changes to unit training plans will persist and cut into a commander’s ability to execute planned training. Creative solutions to accomplish unit training must be considered to ensure combat readiness.

B. RECOMMENDATIONS FOR FURTHER RESEARCH

Existing infrastructure, such as maintenance areas and motor pool space, will play a role when determining the number of systems a unit is able to properly maintain. Looking at current storage and maintenance space within the artillery community, space is already limited due to the current T/E assigned to existing units. Within the construct of Force Design 2030, seventy-five percent of existing artillery units will continue conducting their current roles (Senate Armed Services Committee, 2020). The remaining twenty-five percent will transition into NMESIS units but their associated gearset will increase. Planners should study the effects of adding equipment to existing infrastructure and determine whether additional facilities are required. Restructuring infrastructure will require significant funding but could be a determining factor in the artillery community's ability to maintain combat ready equipment.

With additional assets comes the requirement to conduct additional maintenance, which will require more vehicle and weapon system mechanics to support the force. Force Design 2030 calls for a manpower reduction which implies that planners need to employ innovative design methods to ensure mission essential tasks are accomplished while reducing the strain of manpower, cost, and logistical requirements (United States Marine Corps [USMC], 2021). Distributed employment concepts will also require NMESIS batteries to operate more independently which will require long range digital and voice communications. This will require additional trained communications Marines to facilitate timely fire support. Studies should consider the associated manpower requirement of operating within a distributed littoral environment and ensure personnel are assigned to accomplish supporting tasks for the battery.

Simulators are an integral part of the Marine Corps T&R process. Individual MOS T&R manuals outline the training tasks that can be completed through simulation. This provides commanders with flexibility to accomplish individual level training without the use of training areas, allowing for concurrent task completion. The use of simulations will be vital for completion of ROGUE-Fires training. T&R developers should thoroughly consider training that can be accomplished within a simulator and ensure existing facilities are upgraded to support. Research into the use of simulations for the NMESIS battery will help ensure units can meet their T&R standards.

C. CLOSING

Over the course of Marine Corps history, the service has gained a reputation for the ability to adapt and overcome challenges. As the DOD moves to meet the guidance outlined in the 2018 NDS, the Corps must again adapt to maintain its lethality. Incorporation of new technology will ensure that existing fire support gaps are filled with systems that facilitate mission accomplishment for the Naval service. ROGUE-Fires is one system that will help ensure success within contested littoral combat areas. To effectively fill this mission, the Marine Corps must consider equipment solutions that allow units to meet required training and readiness standards. Failure to consider the secondary effects of replacing legacy crew served cannon artillery with individually operated unmanned systems will result in tactical units that are unable to complete their training criteria. Untrained units will result in mission failure for the Marine Corps and increase the casualty rate for American service members.

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