ICM: BRIDGING THE CAPABILITY GAP BETWEEN 1 JANUARY 2019 AND THE REPLACEMENT MUNITION

A thesis presented to the Faculty of the U.S. Army Command and General Staff College in partial fulfillment of the requirements for the degree

MASTER OF MILITARY ART AND SCIENCE
General Studies

by

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2017

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*	**2. REPORT TYPE**	**3. DATES COVERED** *(From - To)*
9-06-2017	Master's Thesis	AUG 2016 – JUN 2017

4. TITLE AND SUBTITLE

ICM: Bridging the Capability Gap Between 1 January 2019 and the Replacement Munition

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

MAJ Shawn A. Mains

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
U.S. Army Command and General Staff College
ATTN: ATZL-SWD-GD
Fort Leavenworth, KS 66027-2301

8. PERFORMING ORG REPORT NUMBER

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION / AVAILABILITY STATEMENT
Approved for Public Release; Distribution is Unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

Cluster munitions have caused concern around the world due to the potential for unintended harm to civilians due to unexploded ordnance. World leaders from 108 countries signed a treaty in December 2008 that no longer allows the use, storage, or transfer of these munitions. The United States did not sign the treaty but instead chose to enact the Department of Defense (DoD) Policy on Cluster Munitions and Unintended Harm to Civilians in June 2008. This policy applied to all cluster munitions including improved conventional munitions (ICM) utilized by the U.S. field artillery. The endstate of this policy is that by 1 January 2019, all cluster munitions in the DoD inventory will meet a 1 percent or less dud rate. The purpose of this study was to identify possible solutions to bridge the ICM capability gap from 1 January 2019 until an ICM replacement munition is in the inventory.

15. SUBJECT TERMS
DPICM, Convention on Cluster Munitions, Russo-Ukrainian War, ICM Replacement, GMLRS-AW, Field Artillery

16. SECURITY CLASSIFICATION OF:			**17. LIMITATION OF ABSTRACT**	**18. NUMBER OF PAGES**	**19a. NAME OF RESPONSIBLE PERSON**
a. REPORT	**b. ABSTRACT**	**c. THIS PAGE**			**19b. PHONE NUMBER** *(include area code)*
(U)	(U)	(U)	(U)	88	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std. Z39.18

MASTER OF MILITARY ART AND SCIENCE

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The opinions and conclusions expressed herein are those of the student author and do not necessarily represent the views of the U.S. Army Command and General Staff College or any other governmental agency. (References to this study should include the foregoing statement.)

ABSTRACT

ICM: BRIDGING THE CAPABILITY GAP BETWEEN 1 JANUARY 2019 AND THE REPLACEMENT MUNITION, by MAJ Shawn A. Mains, 88 pages.

Cluster munitions have caused concern around the world due to the potential for unintended harm to civilians due to unexploded ordnance. World leaders from 108 countries signed a treaty in December 2008 that no longer allows the use, storage, or transfer of these munitions. The United States did not sign the treaty but instead chose to enact the Department of Defense (DoD) Policy on Cluster Munitions and Unintended Harm to Civilians in June 2008. This policy applied to all cluster munitions including improved conventional munitions (ICM) utilized by the U.S. field artillery. The endstate of this policy is that by 1 January 2019, all cluster munitions in the DoD inventory will meet a 1 percent or less dud rate. The purpose of this study was to identify possible solutions to bridge the ICM capability gap from 1 January 2019 until an ICM replacement munition is in the inventory.

ACKNOWLEDGMENTS

I would like to express my appreciation and gratitude to my committee: Mr. Robert Garven, LTC Joe Schotzko, and Dr. Dale Spurlin for guiding me throughout the course of this study. I found this to be a very informative as well as rewarding process and could not have completed this without you. Thank you.

To my wife, Jeni, who has continued to keep the household intact over the years and through this course of study, been my sounding board for thoughts, continued to keep me motivated, and has been my rock to lean on, thank you. I could not have completed this without you. I also want to thank our son, Chase, and daughters, Olivia, Emmalin, Abigail, and Isabelle. I appreciate your understanding and support through the long hours, disruption to school breaks, and activities missed.

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ACRONYMS

ATACMS	Army Tactical Missile System
ATGM	Anti-Tank Guided Missile
BCT	Brigade Combat Team
BSB	Brigade Support Battalion
BTG	Battalion Tactical Group
CCM	Convention on Cluster Munitions
CP	Concrete-piercing
DIVARTY	Division Artillery
DoD	Department of Defense
DOTMLPF-P	Doctrine, Organization, Training, Materiel, Leadership, Personnel, Facilities, and Policy
DPICM	Dual Purpose Improved Conventional Munition
ERA	Explosive Reactive Armor
EW	Electronic Warfare
FAB	Field Artillery Brigade
FSC	Forward Support Company
GMLRS	Guided Multiple Launch Rocket System
GMLRS-AW	Guided Multiple Launch Rocket System - Alternate Warhead
GPS	Global Positioning System
HE	High Explosive
HHB	Headquarters and Headquarters Battery
HIMARS	High Mobility Artillery Rocket System
HRDR	High Reliability DPICM Replacement

ICM	Improved Conventional Munition
MLRS	Multiple Launch Rocket System
MRB	Motorized Rifle Brigade
MRL	Multiple Rocket Launcher
MTOE	Modified Table of Organization and Equipment
NGW	Next Generation Warfare
PAA	Position Area for Artillery
SAM	Surface to Air Missile
SMArt	Sensor-fused Munition for Artillery
SPAAG	Self-propelled Anti-aircraft Gun
TELAR	Transporter-Erector-Launcher and Radar Vehicle
UAS	Unmanned Aerial System
UXO	Unexploded Ordnance
VT	Variable Time

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CHAPTER 1

INTRODUCTION

Background

Cluster munitions have caused international concern over the years due to the unintended harm caused to non-combatants due to the unexploded ordnance (UXO) created through their use. The United Nations met in Dublin, Ireland and adopted the Convention on Cluster Munitions (CCM) on 30 May 2008. The CCM is an international treaty that prohibits the use, transfer, and stockpile of cluster bombs. This treaty also requires that signatory nations will never use cluster munitions; develop, produce, otherwise acquire, stockpile, retain or transfer to anyone, directly or indirectly, cluster munitions; or assist, encourage or induce anyone to engage in any activity prohibited to a State Party under this convention. The CCM does allow weapons with submunitions that detect and target single objects, do not have indiscriminate area effects, and have electronic self-destruct and self-deactivation mechanisms. Under the CCM, a limited number of the restricted cluster munitions can be kept or acquired for training and development of technology and procedures to detect, clear, and destroy the submunitions. On 3 December 2008, the CCM was opened for signatures in Oslo, Norway. To date, 108 countries have signed the treaty including: Australia, Canada, Germany, and the United Kingdom. Several countries did not sign the CCM including: China, Russia, the United States, India, Israel, Pakistan, and Brazil.[1]

The United States acknowledged the humanitarian concerns addressed in the CCM[1] and took action. Then Secretary of Defense Robert M. Gates issued a policy memorandum on 19 June 2008 where he defined the problem as a struggle between a

needed military capability and protection of the populace from undue harm. As a result, improved conventional munitions (ICM) and other cluster munitions utilized across the joint fires community will be removed from the military's inventory by 1 January 2019. Future munitions that are intended to fill the capability gap left by ICM will be required to have a dud rate not to exceed 1 percent.[2]

Research and development of ICM began in the United States in the early 1950s and finally entered service in 1961 as the M444 105-millimeter projectile. From that point, ICM continued to be refined undergoing additional development and improvement to the capability resulting in two classifications of the munition: Anti-Personnel Improved Conventional Munition and Dual Purpose Improved Conventional Munition (DPICM).[3] ICM was developed to attack a variety of targets effectively utilizing less munitions than with traditional high explosive ammunition. Target sets for ICM included infantry in open fields or trenches; armor formations; command posts; and small, highly mobile, difficult to pinpoint targets with a potentially larger target location error.[4]

The ICM shell carried anywhere from 42 to 644 submunitions (grenades) in a base-ejecting canister that is triggered by a mechanical time fuze. The size and shape of the dispersion pattern changes slightly but can be as large as 150 meters by 150 meters. APICM is most effective against unwarned and exposed personnel. When the canister opens, the grenades leave through the base of the projectile and spread out throughout the target area. As the grenades make contact the ground, the grenade is then hurled upward four to six feet where it functions. DPICM is most effective on light armored and thin skinned vehicles. When the DPICM submunitions are ejected from the canister, a ribbon is deployed to stabilize the grenade during its descent. When the submunitions make

contact with objects in the target area, the shape charge is detonated where it can pierce light armor and the surrounding steel casing acts as shrapnel to nearby personnel.[5]

The United States utilized cluster munitions in Operation Iraqi Freedom in 2003.[6] The munitions did exactly what they were designed to do, kill personnel and destroy equipment. However, the lethality and the reduced number of rounds required to achieve that lethality with ICM rather than high explosive (HE) rounds created potential threats to friendly forces and civilians.

ICM had a failure rate of about 3 percent. This meant that when ICM was fired, approximately three of the 88 submunitions[7] would not function and resulted in UXO that remained in the target area. Now imagine a battalion of 18 howitzers firing six rounds per howitzer at a target. That is just over 9,500 submunitions in a target area and 286 of those submunitions become UXO. ICM was also delivered by rockets and missiles from the M270A1 Multiple Launch Rocket System (MLRS) or the High Mobility Artillery Rocket System (HIMARS). Rockets and missiles carried a significantly larger payload than the cannon fired munitions, up to 644 submunitions per rocket[8] and 950 submunitions per missile.[9] This rapidly becomes an issue as the U.S. military advanced through target areas to the next objectives or to the nearby civilian populace that traffic these areas on a daily basis.

The purpose of this study was to explore options for the U.S. Field Artillery incorporating doctrine, organization, and materiel analysis to identify possible solutions to bridge the capability gap between ICM being no longer authorized for use as of 1 January 2019 and the fielding of an ICM full replacement munition.

Primary Research Question

What should the U.S. Field Artillery do to bridge the capability gap between ICM and an ICM full replacement?

Secondary Research Questions

1. What are the current and future threats that require the U.S. Field Artillery to have an ICM like capability?
2. What changes to doctrine should be made in the absence of an artillery ICM munition?
3. What organizational changes should be made in the absence of an artillery ICM munition?
4. What are the materiel changes or alternatives in the absence of an artillery ICM munition?

Assumptions

The following assumptions were made to enhance the relevance of this study. A materiel solution or multiple solutions will be decided upon to replace ICM across the spectrum of surface to surface indirect fire delivery systems because the Department of Defense (DoD) stated a need for the capability to engage time sensitive, moving, area targets, and targets whose precise locations are not known.[10] The time to develop, test, acquire, and produce a munition to fully replace the capabilities of ICM is what is of most concern and could cause a gap in capability creating a vulnerability to U.S. forces. This study also assumed that the 2008 DoD Policy on Cluster Munitions would remain in effect without further editing or revisions.

Definitions

Base Ejecting. Projectiles are cargo carrying projectiles which typically include a casing which defines a cargo cavity, the cavity being closed at the base of the projectile casing by a releasable end cap.[11]

Cluster Munition. Munitions composed of a non-reusable canister or delivery body containing multiple conventional explosive submunitions.[12] A type of explosive weapon which scatters submunitions ("bomblets") over an area.[13]

Scope

The implications of the DoD Policy on Cluster Munitions are far reaching across the spectrum of joint fires. This qualitative case study focused on the ICM capability gap and potential solutions for the U.S. Field Artillery cannon and rocket systems addressing the doctrine, organization, and materiel areas of DOTMLPF-P (doctrine, organization, training, materiel, leadership, personnel and facilities and policy). There were a number of materiel solutions currently in progress at the various Centers of Excellence. This study mentioned the various new materiel development programs but would not go into depth on the specifics for classification purposes.

Limitations

This qualitative study relied solely on the examination of unclassified documents through public records, visual documents, and online data sources to illuminate problems created by the 2008 DoD Policy on Cluster Munitions and Unintended Harm to Civilians, provided insights to the current and future threats capabilities and limitations, and provided potential solutions in a scientific manner to aid the U.S. Field Artillery to bridge

the ICM capability gap. Due to this study being qualitative in nature, it lacked the statistical data and ability to make general conclusions. There is potential for skewed accuracy in reports as well as written documents that were utilized for this study. This study utilized as many relevant sources as possible in the time available to ensure these outliers in reporting do not affect the research that was conducted. Documents were not produced for the intent of being utilized in future research. This can make the research process difficult and quite cumbersome at times. These documents were utilized as "part of the process to inductively building categories and theoretical constructs"[14] for the purpose of this study.

With the computer age, the internet has been a popular search tool that was utilized in this study. Internet sources were constantly subject to changing content or disappearing data points. In efforts to provide a quality study, version control as well as dates that data points are accessed were paramount. This allowed the researcher, as well as the reader, to identify changes in the data utilized as well as assess its relevance to the study. Additional bias other than those of the researcher can be inadvertently interjected in the research due to the utilization of internet search engines such as Google, Bing, Yahoo, and many others. These biases ranged in the forms of political affiliations of the company to sponsored articles and links. The links and sponsored articles could not be discounted from the available body of knowledge but must be scrutinized, such as any document being utilized for research, for what they could contribute to overall outcome of the research.

Delimitations

The DoD Policy on Cluster Munitions and Undue Harm to Civilians had far reaching effects across the joint fires community. This study was limited to Army and Marine Corps cannon and rocket field artillery systems. The U.S. Air Force, U.S. Navy, and the U.S. Marine Corps took actions to develop solutions to the cluster munition policy but will not be mentioned in this study as the scope would be far too large. This study analyzed the land component's ability to provide fires to shape the objective and support the maneuver force. Where joint fires would be relied on, this study analyzed this from purely the ground perspective. DOTMLPF-P was utilized as the theoretical framework for analysis, this study will only focus on doctrine, organization, and materiel. Doctrine, organization, and materiel were chosen as focus areas due to the ability to rapidly implement recommendations. The various Centers of Excellence and services are covering the spectrum for ICM replacement munitions as well as in-lieu of ICM munitions and will not be of value to this study other than potential timelines to full production and fielding of the munitions. Due to page constraints as well as time for detailed, in-depth analysis, training, leadership, personnel, and facilities will not be covered in this study. Training and leadership were not chosen as focus areas due to the amount of time needed to implement change in these areas. Personnel and facilities were not included because the Total Army Analysis process takes years to be implemented. The United States did not sign the CCM, however, policy on the use of dud-producing ICMs was assumed to be fixed and therefore not covered in this study.

Conclusion

This study explored alternative doctrine, organization, and materiel solutions to the capability gap from losing ICM until a replacement munition could be fielded. The research conducted will provide U.S. Field Artillery and commanders additional options and considerations for implementation while a materiel solution is developed. The doctrine, organization, and existing materiel options analyzed in this study along with a forthcoming materiel solution, will attempt to close the ICM capability gap created by the 2008 DoD Cluster Munitions Policy. Chapter 2 will describe the extant literature relevant to the secondary research questions that will facilitate analysis in chapter 4.

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[1] Wikipedia, "Convention on Cluster Munitions," Wikipedia Foundation, last modified 21 February 2017, accessed 24 February 2017, https://en.wikipedia.org/wiki/Convention_on_Cluster_Munitions.

[2] Secretary of Defense, Memorandum, "DoD Policy on Cluster Munitions and Unintended Harm to Civilians" (Washington, DC: Department of Defense, 19 June 2008), 1-3.

[3] Wikipedia, "Dual Purpose Improved Conventional Munition," Wikipedia Foundation, 15 November 2016, accessed 15 November 2016, https://en.wikipedia.org/wiki/Dual-Purpose_Improved_Conventional_Munition.

[4] Headquarters, Department of the Army, Army Technical Publication 3-09.42, *Fire Support for the Brigade Combat Team* (Washington, DC: Government Printing Office, 2016), Table A-1, A-2 – A-4.

[5] Headquarters, Department of the Army (HQDA), Field Manual (FM) 6-30, *Tactics, Techniques, and Procedures for Observed Fire* (Washington, DC: Government Printing Office, 1991), 6-1.

[6] Justin Sewell, "U.S. Policy on Cluster Munitions and Its Susceptibility to Litigation," *University of Washington Bothell Policy Journal* 13 (Fall 2009): 1, accessed 4 April 2017, https://uwbpolicyjournal.files.wordpress.com/2012/01/u-s-policy-on-cluster-munitions.pdf.

[7] Headquarters, Department of the Army, Technical Manual 43-0001-28, *Army Ammunition Data Sheets Artillery Ammunition Guns, Howitzers, Mortars, Recoilless Rifles, Grenade Launchers, and Artillery Fuzes* (Washington, DC: Government Printing Office, 1994), 3-111.

[8] Wikipedia, "M270 Multiple Launch Rocket System," Wikipedia Foundation, last modified 14 March 2017, accessed 3 April 2017, https://en.wikipedia.org/wiki/M270_Multiple_Launch_Rocket_System#MLRS_rockets_and_missiles.

[9] Wikipedia, "MGM-140 ATACMS," last modified 31 March 2017, accessed 3 April 2017, https://en.wikipedia.org/wiki/MGM-140_ATACMS.

[10] Secretary of Defense, "DoD Policy on Cluster Munitions and Unintended Harm to Civilians," 1.

[11] Google Patents, "Patent US 3677182 A Base Ejecting Projectile," accessed 16 November 2016, https://www.google.com/patents/US3677182.

[12] Secretary of Defense, "DoD Policy on Cluster Munitions and Unintended Harm to Civilians," 1-3.

[13] Sewell.

[14] Sharan B. Merriam, *Qualitative Research: A Guide to Design and Implementation*, 3rd ed. (San Francisco, CA: Jossey-Bass, 2009), 154.

CHAPTER 2

LITERATURE REVIEW

The purpose of this study was to identify possible solutions to bridge the ICM capability gap from 1 January 2019 until an ICM full replacement munition is in the inventory. The following literature review analyzed unclassified public records, visual documents, and online resources utilized to conduct this study. These documents are grouped to provide context to the strengths and weaknesses of U.S. Field Artillery in the categories of doctrine, organization, and materiel to determine if an overmatch exists. The section on Doctrine discussed how the United States fights with artillery. Organization examined how the U.S. artillery task organized for combat in a peer to peer or near peer decisive action fight. The section on materiel examined the munitions currently in the U.S. Field Artillery inventory and described in an unclassified manner the capabilities and limitations of the munitions as compared to purpose and effectiveness of ICM. This section briefly mentioned some of the concepts in development and testing to provide the field artillery with an ICM full replacement.

Doctrine

"The mission of the Field Artillery is to destroy, defeat, and disrupt the enemy with integrated fires to enable maneuver commanders to dominate in Unified Land Operations."[1] The ability of field artillery units to accomplish this mission depends on the system's (forward observers, fire direction centers, and howitzer sections) ability to place effective fires on a target quickly. The longer the field artillery system takes to place rounds on target, the more time the target has to leave the area, increase their degree of

protection, acquire and return fire on the artillery unit (counterfire), and the more rounds it will take to achieve the maneuver commander's desired effects. One method to decrease the number of rounds needed to accomplish the commander's desired endstate is to mass fires.[2] Massing fires is when multiple howitzers or multiple joint fires platforms engage the same target or the same small area.[3] Figure 1 depicts ammunition saved by massing fires and the number of rounds it would take to achieve the same effect by a smaller size firing elements.

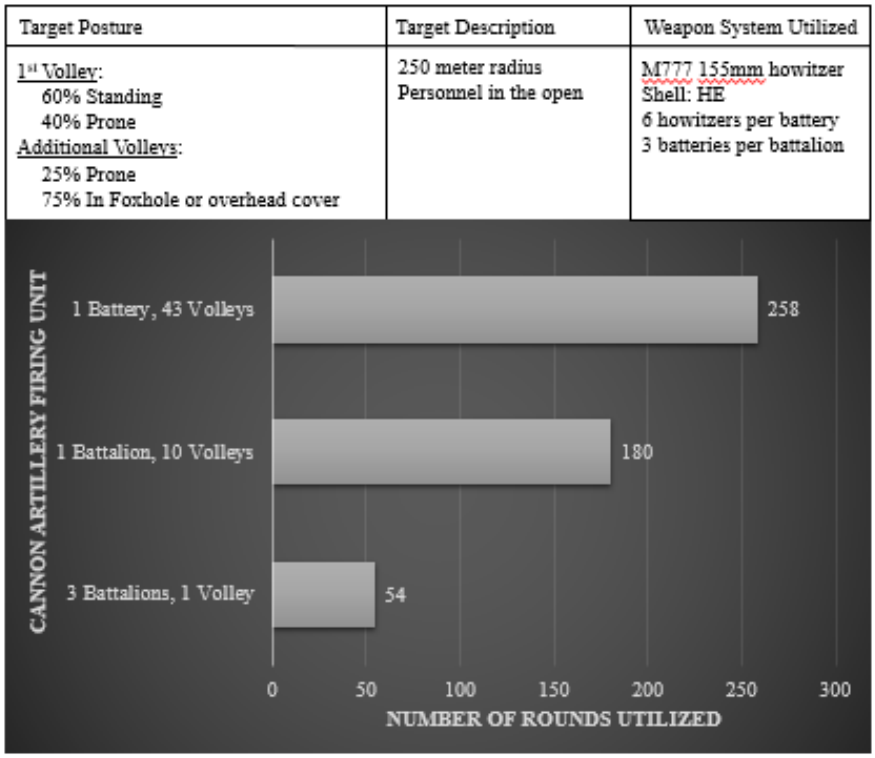

Figure 1. Number of Rounds Required for Equivalent Effect against Soft Targets

Source: Created by author.

Extended firing time as a result of additional volleys utilized to achieve the desired effect, increases the probability of detection by enemy counterfire radar and subsequent counterfire puttting the firing units at greater risk as well as allowing the personnel in the target area to take cover. The three battalions massed would saturate the target area giving the best effects where the lone battery would have good effects on the first volley but decreasing effectiveness during subsequent volleys.

The basic field artillery firing element was the firing platoon. Each platoon contained a fire direction center that controlled where and what the three howitzers of the platoon shot. A firing battery contained two firing platoons that are able to operate separately in different locations or they can combine and maneuver as a battery. The platoon fire direction centers utilize the Advanced Field Artillery Tactical Data System computer to send firing information to the howitzer sections as well as to receive missions from the battalion and brigade. Advanced Field Artillery Tactical Data System is the primary interface between the battalion and the howitzer sections.[4]

Field artillery units are often high payoff targets to the enemy forces and are vulnerable to air, ground, and electronic warfare attack. Many field artillery units have very limited ability for self-defense thus platoon operations are preferred for defending the firing unit. Platoons can disperse and operate as individual howitzer sections when the enemy situation and terrain dictate. Section operations are the least preferred method of employment because the section is isolated and must provide for its own defense. Firing units negate some of their vulnerabilities by being able to disperse, hide, fire, and displace quickly to avoid detection and counterfire. Battery commanders issue survivability movement criteria based on the threat assessment. Survivability movement

criteria can be based on number of rounds fired in current location, time in position, as well as each individual unit's standard operating procedures. The threat to field artillery units can also be mitigated when an external security force such as military police, infantry, or armor units are task organized or directly tasked to do so.[5]

Field artillery firing units are assigned to a position area for artillery (PAA) by the maneuver commander in coordination with the fire support element at that echelon as well as the fire support officer or fire support coordinator. PAAs are a way for the maneuver commander to manage terrain and gives the field artillery units space to maneuver and survive while providing fires. As a result of field artillery units firing from PAAs, they are potentially a location that attracts enemy counterfire and nearby units should stay away from PAAs. Field artillery units do not control the PAAs they are assigned to and do not have the responsibilities associated with a unit that is assigned an area of operation. Other units can traverse through PAAs without coordinating with the field artillery unit that occupied that position. The size of PAAs depends on the type of field artillery unit that will be occupying that position. M109A6 Paladin platoons normally require over four square kilometers for their PAAs while MLRS and HIMARS platoons require 12 square kilometers. PAA positioning should take into consideration possible gun-target lines, high and low angle fires, and how those will affect airspace control and coordination for rotary wing, fixed wing, and tilt-rotor operations. Attempts should be made to laterally deconflict rotary wing, fixed wing, and tilt-rotor corridors from PAAs to allow freedom of action by the field artillery unit as well as the airspace users.[6]

Organization

Division Artillery (DIVARTY) is the senior field artillery command that supports an Army division. DIVARTY, in support of the division, is tasked to deliver fires; integrate all forms of Army, joint, and multinational fires; and conduct targeting. The DIVARTY commander is the division commander's primary advisor on the fires warfighting function and serves as the division fire support coordinator. DIVARTY is the force field artillery headquarters for the division and may be tasked by the division commander to provide training and certification standardization for all field artillery units within the division to include the Brigade Combat Team's (BCT) organic field artillery battalions. The headquarters and headquarters battery (HHB) that contains the signal platoon and target acquisition platoon, is the only unit that is organic to the DIVARTY. One to five field artillery cannon and rocket battalions, typically from a Field Artillery Brigade (FAB), can be task organized to the DIVARTY. When task organized, the DIVARTY will also require augmentation from a combat support sustainment battalion as well as additional signal support due to not having an organic sustainment battalion.[7]

Field artillery cannon battalions are organic or assigned to BCT as well as FAB throughout the Army. The composition within the battalions throughout the various types of BCTs remains relatively the same; however, there are differences in the platforms utilized to support the BCT. Each battalion is comprised of four batteries, the HHB and three firing batteries. HHB typically consists of a battery headquarters, the battalion command section, the battalion staff, a medical platoon, the unit ministry team, the target acquisition platoon, a meteorological team, two survey sections, and a counterfire operations section. A cannon firing battery typically consists of the battery headquarters,

supply section, two firing platoon headquarters with fire direction centers, six howitzer sections, and two ammunition sections. The platoon is the basic firing unit for a field artillery battery. A platoon consists of a platoon headquarters, fire direction center, three howitzer sections, and an ammunition section. Field artillery battalions that support Infantry BCTs consist of two firing batteries of M119 105-millimeter howitzers and one firing battery of M777 155-millimeter towed howitzers. Within a Stryker BCT, the field artillery battalion consists of three firing batteries of M777 155-millimeter towed howitzers. An armor BCT field artillery battalion contains three batteries of M109A6 155-millimeter self-propelled howitzers. Even though the field artillery battalion is organic or assigned to the BCT, the commander may assign a support relationship to one of the BCT subordinate units for a specific mission or task.[8]

The FAB is not organic to any Army organization or echelon and is the only field artillery unit that will typically be employed above the brigade level and may be attached or placed under operational control of a division, corps, joint task force, or a joint force land component commander. FABs have their own Brigade Support Battalion (BSB), network support company, target acquisition battery, and HHB. The FAB is task organized to accomplish assigned tasks with one or up to as many as five battalions of towed M777 155-millimeter howitzers, M109A6 155-millimeter self-propelled howitzers, the tracked M270A1 MLRS, or the wheeled M142 HIMARS. Battalions within the FAB will have two or three firing batteries consisting of eight or six artillery pieces respectively. Each cannon firing battery and platoon are set up the same way as the BCT construct with the only difference potentially being the number of systems. MLRS

and HIMARS batteries consist of a battery headquarters, battery operations center, a support platoon, and two firing platoons with four launchers.[9]

FABs are the only field artillery unit with an organic support assets. Field artillery battalions within a FAB are augmented by a Forward Support Company (FSC), however, when the fires brigades were updated to reflect the FAB modified table of organization and equipment (MTOE), the BSB was reduced to a Headquarter and Service Company consisting of three platoons: a headquarters platoon, a support platoon, and a maintenance platoon. The FSCs are attached to the FAB BSB as required to support the cannon or rocket battalions placed within. FAB BSBs do not have an organic medical company like the BCT BSB thus they depend on area support medical units. Supplies to the FAB come from the combat support sustainment battalion, a corps level asset. The support platoon distribution section is designed and equipped to provide support to the FAB HHB as well as the BSB HSC. The distribution section is not designed to conduct distribution operations to the FSCs except in an emergency situation.[10]

Battalions within a BCT are augmented with a FSC from the respective BSBs. FSCs consist of a company headquarters, a field feeding section, a maintenance platoon, and a distribution platoon. They are organized to provide subsistence, field maintenance, and supply distribution to the field artillery battalion and subordinate batteries.[11] FSCs will provide all classes of supply for the field artillery battalion except for medical supplies which are provided by the HHB medical platoon. The FSCs can operate from the FAB field trains, combat trains, or split and operate from both. They are not designed to carry an authorized stockage list but may carry critical line replaceable units and combat spares when authorized or directed to do so. The maintenance platoon consists of a

maintenance control section, service and recovery section, radar repair team, and a field maintenance section. Within an armor BCT, there are two maintenance support teams to support the firing batteries.[12]

Command relationships provide commanders with a continuously available, adjustable, and tailored all-weather fires package capable of providing support in all types of terrain. There are different types of command relationships as well as inherent responsibilities associated with each. Organic, assigned, attached, operational control, and tactical control are the Army command relationships. Inherent responsibilities associated with the different types of command relationship are: answering calls for fire in priority from, the zone of fire, is positioned by, and has its fires planned by. Table 1 shows the relationship between the types of command relationships and the inherent responsibilities associated with each.[13]

Table 1. Field Artillery Inherent Responsibilities in Army Command Relationships

If Army Command Relationship is-		*Then Field Artillery Inherent Responsibilities are-*			
		Answers Calls for Fire in Priority From:	*Has as Its Zone of Fire:*	*Is Positioned By:*	*Has Its Fires Planned By:*
Army Command Relationship	**Organic**	1. Parent unit. 2. Own observers.[1] 3. Force field artillery headquarters[2]	Area of operations of parent unit.	Organic headquarters	Parent unit.
	Assigned	1. Parent unit. 2. Own observers.[1] 3. Force field artillery headquarters.[2]	Area of operations of parent unit.	Assigned headquarters	Parent unit.
	Attached	1. Gaining unit. 2. Own observers.[1] 3. Force field artillery headquarters.[2]	Area of operations of gaining unit.	Gaining unit	Gaining unit.
	OPCON	1. Gaining unit. 2. Own observers.[1] 3. Force field artillery headquarters.[2]	Area of operations of supported unit.	1. Supported unit 2. Force field artillery headquarters[2]	1. Supported unit 2. Force field artillery headquarters[2]
	TACON	1. Gaining unit. 2. Own observers.[1] 3. Force field artillery headquarters.[2]	Area of operations of supported unit.	1. Supported unit 2. Force field artillery headquarters[2]	1. Supported unit 2. Force field artillery headquarters[2]
Note: (1) Includes all target acquisition means not deployed with the supported unit (such as radars or unmanned aircraft systems), vehicles, air observers, survey parties. In the NATO, the gaining unit may not task-organize a multinational unit (see TACON). ***Note:*** (2) If designated by the supported commander.					
OPCON – operational control NATO – North Atlantic Treaty Organization TACON – tactical control					

Source: Headquarters, Department of the Army, Field Manual 3-09, *Field Artillery Operations and Fire Support* (Washington, DC: Government Printing Office, 2014), 1-32.

Support relationships are utilized: to task organize for a mission; when subordination of one unit to another is inappropriate; and to allow field artillery commanders to employ their units' capabilities to achieve desired results by supported commanders. Some examples of when support relationships are most common are: when support is more effective if a commander with the requisite technical and tactical expertise controls the supporting unit rather than the supported commander (cannon battalion directly supporting an armor brigade); the echelon of the supporting unit is the same or higher than that of the supported unit (example: FAB in support of a BCT); or the supporting unit supports several units simultaneously (HIMARS battery supporting a division with multiple subordinate BCTs). Field artillery units can be placed in a direct support, reinforcing, general support, or general support reinforcing relationship from the BCT up through the joint and multinational forces levels. Table 2 illustrates the inherent field artillery responsibilities within support relationships.[14]

Table 2. Field Artillery Inherent Responsibilities in Army Support Relationships

If Army Support Relationship is –		*Then Field Artillery Inherent Responsibilities Are –*			
		Answers Calls for Fire in Priority From:	***Has as Its Zone of Fire:***	***Is Positioned By:***	***Has Its Fires Planned By:***
Army Support Relationship	***Direct Support***	1. Supported unit. 2. Own observers.[1] 3. Force field artillery headquarters.[2]	Area of operations of supported unit.	Supported unit.	Supported unit.
	Reinforcing	1. Reinforced field artillery. 2. Own observers.[1] 3. Force field artillery headquarters.[2]	Zone of fire of reinforced field artillery unit.	Reinforced field artillery unit HQ.	Reinforced field artillery unit HQ.
	General Support-Reinforcing	1. Supported unit. 2. Force field artillery headquarters.[2] 3. Reinforced unit. 4. Own observers.[1]	Area of operations of supported unit to include zone of fire of reinforced field artillery unit.	1. Supported unit. 2. Force field artillery headquarters.[2]	1. Supported unit. 2. Force field artillery headquarters.[2]
	General Support	1. Supported unit. 2. Force field artillery headquarters.[2] 3. Own observers.[1]	Area of operations of supported unit.	1. Supported unit. 2. Force field artillery headquarters.[2]	1. Supported unit. 2. Force field artillery headquarters.[2]
Note: (1). Includes all target acquisition means not deployed with the supported unit (radar, unmanned aircraft systems), vehicles, air observers, survey parties. In the NATO, the gaining unit may not task-organize. ***Note:*** (2). If designated by the supported commander.					
NATO – North Atlantic Treaty Organization					

Source: Headquarters, Department of the Army, Field Manual 3-09, *Field Artillery Operations and Fire Support* (Washington, DC: Government Printing Office, 2014), 1-34.

Nonstandard support relationships can be utilized by commanders and are usually a variation of the standard support relationships discussed previously. Commanders can place limitations or guidance concerning ammunition, unit positioning, or other mission critical factors to tailor the field artillery assets in support of future operations. Some examples of nonstandard support relationships would be for a unit in a general support-reinforcing role to not expend more than 25 percent of their controlled supply rate in support of the reinforced unit or for a unit in a general support role to provide a liaison officer to the corps fires cell. To change a unit from one type of support relationship to another, an on-order mission will be utilized. An example of an on-order support change

would be 3-27 Field Artillery is general supporting-reinforcing to 1-7 Field Artillery; on-order reinforcing to 1-7 Field Artillery.[15]

Materiel

Improved Conventional Munitions

ICM was created to offer greater target effects with fewer munitions than traditional HE against large, poorly located, or moving area targets ranging from personnel to materiel.[16] When compared to M107 HE, ICM was found to be 50 percent more effective. Dispersion areas varied based on the caliber of the weapon system. ICM fired from a 155-millimeter howitzer dispersed the submunitions over an 18,000-square meter area. MLRS fired ICM spread out over a 40,000-square meter area and ATACMS based ICM covered 33,000-square meters.[17]

To illustrate the effectiveness of ICM versus HE munitions, imagine an area target with a diameter of 250 meters. A total of 60 percent of the troops in the target area are standing and the other 40 percent are laying in the prone. In this scenario, the same number of HE impact fuzed, HE airburst fuzed, and ICM munitions are fired. HE with airburst fuzing will create slightly more casualties than HE with impact fuzing. ICM will more than double the number of casualties created by HE with impact fuzing and almost double the casualties created by HE with airburst fuzing.

Reset the target area in your mind. In this scenario, the number of casualties created will be the same between the same three munitions. HE with airburst fuzing requires more than double the number of ICM rounds utilized and HE with impact fuzing utilized more than three times the number of ICM rounds.[18] One cannon fired ICM projectile can equal the same lethal effects as 15 non-cluster munitions. In Operation

Desert Storm, ICM proved just as effective of a psychological weapon as it did a kinetic weapon. Iraqi Army units watched as neighboring units were decimated by ICM causing some to lose the will to fight.[19]

High Explosive

HE is a surface to surface fired cannon artillery munition that can be fuzed to attack a number of potential targets assigned for a field artillery unit. Fuzing options for HE included: impact, time, or proximity. Impact fuzing, referred to also as quick, bursts upon impact with the ground, the target, or anything else that it may hit. Targets where quick fuzing was utilized were: personnel standing or prone, unarmored vehicles, and light materiel. Quick fuzing begins to lose its effectiveness when targets were located in uneven terrain, trenches, inside frame style buildings, and earthworks. This fuze also has a delay setting where upon impact, the fuze delays functioning for 0.05 seconds. This delay in functioning will allow the munition to penetrate as well as ricochet. Delay was utilized in dense woods, trenches, deep foxholes, and against soft skinned vehicles. When utilized for ricochet, the munition was fired with a high charge from the howitzer on a low impact angle at a very hard surface and resulted in a low airburst.

Another fuzing option for HE munitions was a time fuze. The time fuze functions at a set time (determined by the fire direction center and set by the gun crew) along the trajectory of the munition resulting in an airburst. Proximity fuzing, also known as variable time (VT), was an updated version of the time fuze. VT utilized radio waves to make the fuze function at a predetermined height of burst. This provided the same effect as the time fuze, but does not have to be adjusted. Earlier VT fuzes had a pre-determined height of burst set for 20 meters above the ground and could not be utilized in rain, snow,

or icy conditions. Subsequent versions of the fuze function at seven meters above the ground and were able to be utilized in any condition. Targets for fuzes time and VT were troops in the open, troops in trenches, troops in deep foxholes, and soft skinned vehicles.

Concrete-piercing (CP) fuzes allowed HE munitions to attack concrete structures as well as earth and log reinforced positions. Within CP there were two types of fuzes, non-delay and delay. The CP non-delay fuze was utilized for spotting by the forward observer, clearing rubble, and shattering concrete. CP delay fuze was utilized to destroy the concrete target.[20]

Excalibur

The Excalibur was a surface-to-surface, 155-millimeter cannon artillery projectile that could be fired from the M777A2 and M109A6 Paladin platforms. Excalibur was a fin-stabilized projectile that glided to its target and could achieve ranges in excess of 35,000 meters. It utilized an inertial measurement unit and Global Positioning System (GPS) to attack point targets hitting less than 10 meters from the intended target in an unjammed environment. Excalibur was designed to attack point targets such as personnel, light materiel, and personnel within structures at extended ranges in complex terrain with minimal collateral damage.

The Army has utilized Excalibur in combat since 2007 in Iraq and 2008 in Afghanistan.[21] The Army planned on fielding three Excalibur variants, HE, smart, and discriminating. The HE variant was currently in the field artillery inventory and has been upgraded several times. The smart variant would have been able to target moving vehicles as well as time-sensitive-targets. The discriminating variant was projected to search, detect, and selectively engage individual vehicles by specific target

characteristics. The smart and discriminating variants do not have a projected timeline associated with the projectiles.[22]

Guided Multiple Launch Rocket System

The Guided Multiple Launch Rocket System GMLRS) was a 19-foot long, 9-inch in diameter rocket that carries a 196-pound unitary warhead. The rocket has an all-weather, GPS-aided inertial guidance package that enabled engagement of precision point targets that required low collateral damage out 70 kilometers. GMLRS was equipped with a tri-mode fuze that allowed the rocket to function in point detonation, delay, or proximity settings. It was carried and stored in a six-shot pod that could be fired by the M270A1 MLRS or M142 HIMARS launchers. More than 25,000 rockets have been produced for the United States and allied partners with over 3,000 being fired in combat. Primary users of the GMLRS were the United States, France, Germany, Italy, the United Kingdom, as well as five other allied nations with additional allies evaluating the system to be purchased in the future.[23]

Guided Multiple Launch Rocket System–Alternate Warhead

The Guided Multiple Launch Rocket System – Alternate Warhead (GMLRS-AW) (XM30E1) was a surface to surface, inertial measurement unit and GPS guided rocket that was designed to replace the GMLRS DPICM rocket. This rocket could be fired from the M270A1 MLRS or the M142 HIMARS launchers and had an effective range out to 70 kilometers. GMLRS-AW utilized the same rocket motor, guidance system, and control systems as the M31A1 GMLRS unitary warhead but carried a 200-pound HE warhead packed with approximately 160,000 preformed tungsten fragments. There were no

submunitions in the GMLRS-AW thus meeting the UXO rate of less than 1 percent as defined by the 2008 DoD Policy on Cluster Munitions and Unintended Harm to Civilians. Intended targets for the GMLRS-AW were area or imprecisely located targets such as those during counterfire missions, air defense sites, command posts, assembly areas, light materiel, and other high payoff targets.[24] There were some target sets that GMLRS-AW was not effective against, but the report is classified. Detailed testing results could be obtained from the Director of Operational Test and Evaluation classified report dated 26 March 2015. GMLRS-AW entered full rate production on 8 April 2015[25] and was currently available in the U.S. Field Artillery inventory.

Army Tactical Missile System

Army Tactical Missile System (ATACMS) was a long-range, all weather missile with a high explosive, single burst warhead that could be fired from the M270A1 MLRS or M142 HIMARS launchers. The missile had the ability to engage high pay-off, time-sensitive, and hard targets through the utilization of a multifunction fuze in mountainous or urban terrain where collateral damage was of concern.[26]

Munitions and Equipment in Development

Sensor-fused Munition for Artillery, or SMArt 155, was developed by the leading German ammunition makers in the 1980s. This munition was developed specifically for attacking stationary or moving armored targets. Each artillery round carried two intelligent submunitions that were able to detect armored targets and defeat main battle tanks with its explosively formed projectile. The SMArt 155 had a multi-mode sensor system capable of identifying as well as rejecting false targets. Collateral damage was a

concern to the designers so a redundant self-destruct mechanism was incorporated into the round if no targets are detected. The SMArt 155 was fielded by the armies of Germany, Switzerland, Greece, and Australia.[27]

The Marine Corps has been working with developers for production of a High Reliability DPICM Replacement (HRDR) munition. HRDR would have increased the legacy DPICM submunition reliability to 99 percent meeting the 2008 DoD policy standards of not more than 1 percent UXO that would have allowed the Marine Corps to retain the area effect munition capability. The expected cost of the upgrade for DPICM through fiscal year 2019 was projected to be $22.4 million with the munition ready for use by late 2019 or 2020. The projected impact of this initiative not being funded was the Marine Corps increasing procurement of the HE projectile M795 by four times as well as needing a 56 percent increase in load transportation assets at the battalion level.[28]

The Army had been considering its options for the aging ATACMS munitions. Options under consideration are a service life extension for the ATACMS, restart of the ATACMS production line, development of a new missile to replace ATACMS, and other options that were built by U.S. allies. The Army wanted to downsize the field of potential contractors to one by 2018 or 2019 to begin full-scale development and wanted to have the missile in production by 2021 or 2022. Reportedly, Raytheon, Boeing, and Lockheed Martin (developer of the ATACMS) had been interested in the potential contract.[29] Raytheon had a concept for a new Long Range Precision Fires Missile that aimed to replace the aging ATACMS inventory. The Long Range Precision Fires Missile was designed to be an all-weather, day and night capable munition with a range out to 500 kilometers attacking bunkers, vehicle and aircraft staging areas, troop concentrations, and

other stationary or fixed type targets. The missile was designed to be fired from the existing M270A1 MLRS or M142 HIMARS launchers but would double the payload of the ATACMS with two missiles per pod. The Army awarded Raytheon risk mitigation contract worth 5.7 million dollars. Company executives believed the project would be operational around 2027[30] five years later than the Army claimed to want the new missile.

Engineers at Picatinny Arsenal were in the development process for an extended range cannon artillery modification to the M777. This project would have added six feet to the length of the cannon tube as well as added just under 1,000 pounds to the overall system weight. Dubbed as the M777 extended range (M777ER), this modification could have potentially pushed the previous maximum range of 30,000 meters out to 70,000 meters and allowed U.S. cannon units to out range adversary cannon units. The Armament Research, Development, and Engineering Center would have utilized this testing to determine if the modification was suitable for the M777 system or if an entirely new system would be needed. Additional testing was planned for the M109 series Paladin self-propelled howitzers and if suitable would have been incorporated into the M109A7 upgrade.[31]

Russian Equipment

Tanks and Infantry Fighting Vehicles

The T-72 main battle tank entered service in 1972 and has underwent many upgrades. Weighing in at 41.5 metric tons, the tank was protected by 500 millimeters of armor with first generation explosive reactive armor (ERA) available for added protection. This tank has a crew of three, features a 125-millimeter smooth bore main

gun, 7.62-millimeter coaxial machine gun, and a 12.7-millimeter anti-aircraft machine gun mounted to the top of the turret. The main gun had a range of 5,000 meters during the day and 2,600 meters at night and could be fired on the move but the tank commander cannot fire the main gun. The T-72B added an anti-tank guided missile (ATGM) that was upgraded again in the T-72BM variant and was able to penetrate more than 900 millimeters of armor behind ERA.[32]

The T-90S was introduced in 2002 and weighed in at 46.5 metric tons. The crew of three was protected by 840 millimeters of armor with second generation ERA. The T-90S was outfitted with a 125-millimeter smooth bore main gun that was capable of firing tank rounds as well as ATGMs. The main gun could have achieved ranges out to 5,200 meters during the day and 4,000 meters at night. Cannon launched ATGMs could range out to 5,000 meters during the day and 2,600 meters at night firing two to three rounds per minute and was capable of defeating more than 900 millimeters of armor behind ERA.[33]

The latest development in armored formations from Russia was the T-14 Armata MBT that featured a 125-millimeter main gun that could possibly have been upgraded to a 152-millimeter main gun in the future. The fully automated and unmanned turret could have fired 10-12 rounds per minute as well as ATGMs and anti-aircraft missiles. The upgraded ATGMs could have ranged out to 8,000 meters and were coupled with a 12.7-millimeter anti-aircraft gun and 7.62-millimeter machine gun that were also remotely fired by the crew. The 12.7-millimeter anti-aircraft gun could have potentially been replaced by a 30-millimeter anti-aircraft gun that could also have been remotely fired by the crew.

Protecting the crew in this 48-ton machine was more than 900 millimeters of rolled homogeneous armor equivalent along with dual ERA along the front, sides, and top of the tank. Software onboard the T-14 could have monitored both air and ground threats and either suggested a firing solution to the crew or could have been set to automatically destroy the threat using the main gun or one of the mounted machine guns. Protecting the T-14 was an active protection system that claimed to have been able to defeat unguided rockets and artillery as well as third and fourth generation ATGMs such as the TOW (Tube-launched, Optically-tracked, Wire-guided; Hellfire; Javelin; and sensor-fuzed weapons. It was also claimed that the active protection system was effective against depleted uranium tank rounds. This platform was slated to not only serve in a tank role but would have been integrated into an air defense network or have been utilized in a reconnaissance role.[34] The source for the information about the T-14 was suspect as it appears that the information has been cobbled together from various other sources and states the claimed capabilities of the T-14. This tank appeared to be in development and not fully fielded so true capabilities will not be known until tested in battle.

The Russian BMP-1 infantry fighting vehicle was introduce in 1970 and has undergone several configurations and upgrades over the years. The vehicle had a crew of three and carried six passengers in the back. This amphibious vehicle weighed 13.3 metric tons and had 19-23 millimeters of armor to protect the crew and passengers. Armed with a 73-millimeter smooth bore main gun, the BMP-1 could have ranged out to 800 meters during day or night but could have only reached about 600 meters when firing on the move. A 7.62-millimeter coaxial machine gun and ATGM launcher firing AT-3 wire guided missiles rounded out the BMP-1's armament. In 1974, the BMP-1 was

upgraded to the BMP-1P and extended the range of the main gun to 1,000 meters and added the AT-5 ATGM.[35]

The BMP-2 entered service in 1980. Weighing 14.3 metric tons, it had 23-33 millimeters of armor protecting the crew and passengers. This amphibious vehicle had a crew of three with seating for seven in the back. The main gun was a 30-millimeter automatic gun that could have ranged out to 4,000 meters during the day and 1,300 meters at night. The BMP-2 has a 7.62-millimeter coaxial machine gun in the turret as well as an AT-5b ATGM with a range of 4,000 meters and the ability to punch through 950 millimeters of rolled homogeneous armor.[36]

The BMP-3M infantry fighting vehicle was introduced in 1998 and has a crew of three and seating for seven passengers. This amphibious vehicle weighed 18.7 metric tons and has 30-100 millimeters of armor with ERA added. The 100-millimeter main gun fired eight to ten rounds per minute and could range out to 7,000 meters during the day and 5,000 meters at night. Additional armament for the BMP-3M included the 7.62-millimeter coaxial machine gun as well as the AT-10b laser guided ATGM that could range 5,500 meters during the day and 5,000 meters at night and was capable of affecting targets with 750 millimeters rolled homogeneous armor behind ERA.

Artillery Systems

The D-30 was a 122-millimeter towed Russian howitzer. It has a crew of five and could be emplaced in one minute 30 seconds and displaced three and one half minutes. The D-30 could have fired in bursts of eight rounds per minute, normal at six rounds per minute, and sustained at four rounds per minute. This system could have ranged out to 15,300 meters with HE and 21,900 meters utilizing rocket assisted projectile. The D30's

limitation was that it was not able to conduct digital operations and was restricted to voice operations.[37]

The 2S19 was a Russian 152-millimeter self-propelled howitzer that weighed 42 metric tons. It was crewed by five personnel and the entire section contained seven personnel with the two ammunition carriers. The 2S19 could have been emplaced as well as displaced in one to two minutes and was capable of digging its own firing position in 40-60 minutes. At the burst rate of fire, the 2S19 was capable of shooting eight rounds per minute, normal rate of fire was six rounds per minute, and two rounds per minute when it utilized the sustained rate of fire. Utilizing an HE projectile, the 2S19 could have achieved ranges of 24,700 meters and 29,000 meters using the HE base bleed projectile. The 2S19M1-155 was the 155-millimeter variant that could shoot HE extended range projectiles out to 34,000 meters, HE base bleed projectiles out to 41,000 meters, and DPICM base bleed projectiles out to 45,000 meters.[38]

The BM-21 was introduced in 1963 and was a 122-millimeter multiple rocket launcher (MRL) that carried 40 rockets. The six-wheeled vehicle weighed 13.7 metric tons, has light armor as well as a self-entrenching blade. The BM-21 took three minutes to emplace and two minutes to displace. It was capable of launching all 40 rockets in a matter of 20 seconds or it could have launched single rockets with one-half second between rockets from within the cab or on a 64-meter remote firing device. The BM-21 was capable of being manually reloaded by the crew in 10 minutes. It had the ability to have achieved ranges out to 20,380 meters with HE rockets. Other munitions available to the BM-21 were anti-tank mines, anti-personnel mines, smoke, incendiary, radio

frequency-jamming, and illumination rockets. The BM-21 was the most proliferated MRL throughout the world.[39]

The 9A52-2, also known as the BM-30 Smerch,[40] was a long range, 300mm MRL on an eight-wheeled chassis introduced to the Russian military in 1989. This vehicle weighed 43.7 metric tons, was navigated by way of GPS, crewed by four soldiers, and was capable of being emplaced as well as displaced in three minutes. Automated fire control systems allowed this weapon to fire all 12 rockets in 38 seconds or it could have fired a single rocket every three seconds. The launcher could be reloaded in 36 minutes with support from a transloader vehicle and crew. Munitions that were available to this system included HE, DPICM, sensor-fuzed munitions, smoke, incendiary, chemical, and thermobaric warheads with a minimum range of 20 kilometers and a maximum range of 90 kilometers. The 9A52-2 launcher, transloader and Vivary Fire Control System together are called Complex 9K58.[41]

Air Defense Systems

Russians have produced a wide variety of surface to air missiles (SAMs). The SA-7 was introduced in 1972 and was later upgraded to the SA-14, and SA-16. The latest model produced by the Russians is the SA-18 Grouse. This system was introduced in 1983 and outfitted with a crew of two soldiers, the launcher operator and the loader. The system could fire a missile every 16 seconds and was designed to attack fixed wing and rotary wing aircraft. These systems have also been utilized to attack unmanned aerial vehicles. The horizontal range of the Grouse could exceed 6,000 meters and a vertical range near 11,500 feet above ground level at a speed of mach two (1,534.54 miles per hour) with an automatic self-destruct function at 11 seconds of flight. The missile was

equipped with an HE warhead and guided by a passive infrared homing seeker with a contact fuze. The seeker was designed to be resistant to pyrotechnic and electronically operated infrared countermeasures.

SA-18 missiles were upgraded and designated as the SA-24 Igla-S (Igla-Super). The upgrade gave the missile a proximity as well as contact fuzing, larger explosive charge, and increased fragmentation. Along with the upgrade came an increased resistance to flares and other infrared countermeasures giving the SA-24 an increased probability of hit and probability of kill at all altitudes. The SA-18 or SA-24 have been be mounted on a variety of vehicles from infantry fighting vehicles, armored personnel carriers, as well as self-propelled anti-aircraft guns (SPAAG). When SA-18 batteries are deployed with a brigade or division, they are equipped with an armored command vehicle[42] with a Dog Ear Radar that extended the detection range out to 80 kilometers.[43]

Another common air defense system was the ZSU 23-4 Shilka SPAAG. Shilkas were introduced in 1965 with a crew of four and weigh 20.5 metric tons. Armed with four 23-millimeter liquid cooled guns, the Shilka's rate of fire can reach 850-1000 rounds per minute but were usually employed in a 10-30 round burst. A variety of ammunition could be utilized in the Shilka including HE, HE-Incendiary, armor piercing-incendiary, armor-piercing discarding sabot with tracer, and frangible armor-piercing discarding sabot. The horizontal range of these munitions could exceed 2,500 meters and a vertical range up to 5,000 feet above ground level.

This system was designed to attack low flying aircraft and mobile ground targets while on the move or in a fixed position. The Gun Dish radar mounted to the top of the vehicle allowed it to detect targets out to 20 kilometers and track targets at 13 kilometers.

These systems have been widely proliferated and upgraded with the newest Russian upgrade labeled as the ZSU 23-4M4 which added four SA-18 missiles, an improved radar, and computer based fire control system with upgraded day and night sights. Shilkas were organized in batteries that contain four SPAAGs with one resupply vehicle that held an additional 3,000 rounds for each SPAAG.[44]

Russia has fielded a vast array of SAM systems that can be linked into their integrated air defense system. One of these systems is the SA-11FO better known as the BUK-M1-2. Introduced in 1997, this transporter-erector-launcher and radar vehicle (TELAR) was an armored tracked vehicle that weighed more than 32 metric tons and was crewed by four soldiers. Mounted on each vehicle were four SAMs designed to attack fixed and rotary wing aircraft, Unmanned aerial vehicles, air to surface missiles, artillery rockets, naval vessels, and ground targets. The missiles have achieved speeds over 2,600 miles per hour and engaged airborne targets out to 42 kilometers and as high as 82,000 feet AGL. Ground targets have been engaged with this system out to 15 kilometers and it was designed to also engage naval vessels out to 25 kilometers. This system typically utilized two missiles per target with a 70 percent probability of hit against theater ballistic missiles and an 80 percent probability of hit against all other targets. Missiles have a contact and proximity fuze option on the 154-pound warhead that have produced a kill radius of 17 meters. TELARs have built in protection and countermeasures in the form or active and passive jamming capability and for added survivability when operating as part of the integrated air defense system, one TELAR will operate its radar while the other TELARs are passive and receive information digitally from the other system.

Russia made a follow-on to this system called the SA-17 Grizzly. The upgraded system gave an increased probability of hit for fixed and rotary wing aircraft up to 90 percent and 80 percent for theater ballistic missiles and ground targets. A BUK-M1-2 battery contained two Giraffe radar vehicles, four TELARs, a radio frequency intelligence system, and a support coordination vehicle. When configured as a battalion, 24 targets can be engaged simultaneously.[45] The BUK surface to air system made news headlines in 2014 and was blamed for the 17 July 2014 destruction of Malaysian Airlines flight 17 over Eastern Ukraine that killed all 298 passengers and crew on board.[46]

Employment

Russia typically employed these systems within a division but the 2008 war with Georgia showed that the division concept was too bulky and top heavy for the fast pace of modern conflict. The division was a Cold War relic that was suited for the anticipated all out conventional war with the west. Russia converted the legacy divisions into 83 brigades of which only two are purely tank brigades with the transformation completed by December 2009. A new brigade was anywhere from two or up to two and one half times the size of the regiments under the former division system and come with their own combat support as well as combat service support elements.[47]

The emphasis for the creation of the Motorized Rifle Brigade (MRB) was focused on a force that could be autonomous, versatile, and had a lot of firepower. MRBs contained one tank battalion with four tank companies; three motorized rifle battalions with three motorized rifle companies and one mortar battery each; two cannon artillery battalions with three batteries; one MRL battalion with three batteries; one air defense missile battalion with three batteries; one air defense missile artillery battalion with three

batteries; an engineer battalion with a sapper company, a construction company, a technical company, and a pontoon bridging company; a signal battalion; a maintenance battalion with five maintenance companies; one reconnaissance company, one nuclear, biological, and chemical defense company, one electronic warfare company, a medical company, and one sniper platoon. The cannon artillery battalions in the MRB contained the 2S19 self-propelled howitzers with three batteries of six howitzers and a total of 36 howitzers in the MRB. The MRL battalion contained the BM 21 and was organized in the same manner giving the MRB 18 BM 21 MRLs.[48]

The MRBs were further subdivided into three Battalion Tactical Groups (BTG). Each BTG has one armor company, three mechanized infantry companies, one anti-tank company, two to three cannon artillery batteries, one MRL battery, and two air defense batteries. The amount of firepower contained within the BTG allows its punch to exceed well above its relative echelon. The Russians have typically utilized their self-propelled cannon artillery in a direct fire role which resulted in an extended frontal fires capability out to 6,000 meters.[49] Due to the increased ranges of supporting artillery and the increased lethality of the modern battlefield, a low force to space ration has been utilized by the Russians and their forces are dispersed across a much larger area. A modern BTG would operate in what was the footprint of a cold war era brigade allowing increased chances for survival and increased coverage in area for the unit.[50]

Summary

This chapter discussed how U.S. Field Artillery assets are doctrinally employed, their organization within the various BCTs and FABs, as well as the cannon, rocket, and missile munitions that were available in the inventory at the time this study was

conducted. Some future concepts for munitions were discussed that are forecasted to meet the 1 percent or less UXO rate as set forth in the 2008 DoD Policy on Cluster Munitions and Unintended Harm to Civilians. U.S. cannon and rocket artillery systems have been shown to be capable of independent operations down to the platoon level as well as the ability to mass at the brigade and in theory at the division level should the requirement emerge. The Russian military has not been shown to have a digital capability on all systems but has task organized two to four cannon and rocket artillery batteries to support a maneuver battalion. This section has illustrated that the U.S. cannon systems are out ranged by as much as 50 percent by the Russian cannon systems and 20 kilometers in rocket systems. Chapter 3 will describe the methodology that was utilized to conduct this research that was informed by this literature review.

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[1] Headquarters, Department of the Army (HQDA), Army Doctrine Reference Publication (ADRP) 3-09, *Fires* (Washington, DC: Government Printing Office, 2012), 1-4.

[2] HQDA, FM 6-30, 1-2 - 1-3.

[3] HQDA, FM 3-09, 2-2.

[4] Ibid., 1-52.

[5] Ibid, 1-52 - 1-53.

[6] Ibid, 4-14 - 4-15.

[7] Headquarters, Department of the Army (HQDA), Army Technical Publication (ATP) 3-09.23, *Field Artillery Cannon Battalion* (Washington, DC: Government Printing Office, 2015), 1-2.

[8] HQDA, FM 3-09, 1-38, 1-40.

[9] Ibid, 1-35 - 1-37.

[10] Headquarters, Department of the Army, Army Technical Publication 4-90, *Brigade Support Battalion* (Washington, DC: Government Printing Office, 2014), C1.

[11] HQDA, FM 3-09, 1-35, 1-37 – 1-40.

[12] HQDA, ATP 3-09.23, 1-5.

[13] HQDA, FM 3-09, 1-31 – 1-32.

[14] Ibid, 1-32 – 1-33.

[15] Ibid, 1-34 – 1-35.

[16] Army Capabilities Integration Center (ARCIC), "Area Effects Assessment Brief v2.00" (PowerPoint presentation, Fires Center of Excellence, Fort Sill, OK, 27 March 2015), 6.

[17] Ove Dullum, "Cluster Weapons – Military Utility and Alternatives" (Norwegian Defence Research Establishment, Kjeller, Norway, 1 February 2008), accessed 13 April 2017, http://www.ffi.no/no/Rapporter/07-02345.pdf.

[18] HQDA, FM 6-30, 1-4. ATP 3-09.30, Techniques for Observed Fire, dated: August 2013, not used due to distribution restrictions.

[19] Michael Jacobson, "Why Cluster Munitions Must Be Replaced," *War on the Rocks*, 2 September 2014, accessed 6 April 2017, https://warontherocks.com/2014/09/why-cluster-munitions-must-be-replaced/.

[20] HQDA, FM 6-30, 4-9 – 4-10.

[21] Office of the Director, Operational Test and Evaluation, "Excalibur Increment 1b M982E1," *FY14 Army Programs* (Washington, DC: Operational Test and Evaluation, January 2015), accessed 31 March 2017, http://www.dote.osd.mil/pub/reports/FY2014/pdf/army/2014excalibur_xm92.pdf, 135-136.

[22] Office of the Director, Operational Test and Evaluation, "Excalibur XM982 Precision Engagement Projectiles," *Army Programs* (Washington, DC: Operational Test and Evaluation, January 2009), accessed 31 March 2017, http://www.dote.osd.mil/pub/reports/FY2008/pdf/army/2008excalibur.pdf, 59-60.

[23] Lockheed Martin, "GMLRS Combat Proven - Always Ready to Fire," 2011, accessed 31 March 2017, http://www.lockheedmartin.com/content/dam/lockheed/data/mfc/pc/guided-unitary-mlrs-rocket/mfc-gu-mlrs-rocket-pc.pdf.

[24] Office of the Director, Operational Test and Evaluation, "Guided Multiple Launch Rocket System - Alternate Warhead (GMLRS-AW) XM30E1," *FY 14 Army Programs* (Washington, DC: January 2015), accessed 14 November 2016, http://www.dote.osd.mil/pub/reports/FY2014/pdf/army/2014gmlrs.pdf, 109-110.

[25] Ibid., 113-114.

[26] Lockheed Martin Media, "Lockheed Martin Receives $79 Million Contract for Production of Unitary Army Tactical Missiles," 19 July 2005, accessed 30 March 2017, http://news.lockheedmartin.com/2005-07-19-Lockheed-Martin-Receives-79-Million-Contract-for-Production-of-Unitary-Army-Tactical-Missiles.

[27] Oliver Hoffmann, "Germany's SMArt 155 Sensor-Fused Artillery Ammunition Stops Tanks in Their Tracks," Rhinemetall Defense, 15 February 2010, accessed 30 March 2017, https://www.rheinmetall-defence.com/en/rheinmetall_defence/public_relations/news/detail_1433.php.

[28] ARCIC, "Area Effects Gap Assessment with Loss of Artillery Cluster Munitions," 36.

[29] John Keller, ed., "Raytheon to Help Army Develop New Long-Range Artillery Rocket for Battlefield Fire-Support," Military and Aerospace Electronics, 16 March 2016, accessed 30 March 2017, http://www.militaryaerospace.com/articles/2016/03/artillery-rocket-fire-support.html.

[30] Kris Osborn, "US Army's New Ground-Launched Missile: Raining Down Death from 500 Kilometers Away," *The National Interest*, 6 September 2016, accessed 30 March 2017, http://nationalinterest.org/blog/the-buzz/us-armys-new-ground-launched-missile-raining-down-death-500-17606.

[31] David Vergun, "Top 10 Army Modernization Efforts of 2016," *Redleg Update* (March/April 2017): 9.

[32] U.S. Army Training and Doctrine Command Intelligence Support Activity (TRISA), *Worldwide Equipment Guide Volume 1: Ground Systems* (Fort Leavenworth: U.S. Army Training and Doctrine Command G-2, 2011), 5-25 – 5-38.

[33] Ibid., 5-35 – 5-38.

[34] Wikipedia, "T-14 Armata," Wikipedia Foundation, last modified 30 March 2017, accessed 2 April 2017, https://en.wikipedia.org/wiki/T-14_Armata.

[35] TRISA, *Worldwide Equipment Guide Volume 1: Ground Systems*, 3-29 – 3-32.

[36] Ibid., 3-33 – 3-36.

[37] Ibid., 7-19.

[38] Ibid., 7-29 – 7-30.

[39] Ibid., 7-41.

[40] Wikipedia, "BM 30 Smerch," Wikipedia Foundation, last modified 1 April 2017, accessed 13 April 2017, https://en.wikipedia.org/wiki/BM-30_Smerch.

[41] TRISA, *Worldwide Equipment Guide Volume 1: Ground Systems*, 7-49.

[42] Ibid., 6-51 – 6-54.

[43] Ibid., 6-15.

[44] Ibid., 6-49.

[45] Ibid., 6-73

[46] Somini Sengupta and Andrew Kramer, "Dutch Inquiry Links Russia to 298 Deaths in Explosion of Jetliner Over Ukraine," *New York Times*, 28 September 2016, accessed 7 April 2017, https://www.nytimes.com/2016/09/29/world/asia/malaysia-air-flight-mh17-russia-ukraine-missile.html?_r=0.

[47] Rod Thornton, "Military Modernization and the Russian Ground Forces" (Monograph, Strategic Studies Institute, U.S. Army War College, Carlisle Barracks, PA, 2011), 21-23, accessed May 6, 2017, https://ssi.armywarcollege.edu/pdffiles/PUB1071.pdf.

[48] Rob O'Gorman, "Fire on Ice: Russia's New Artic Brigades," Offizere.ch, 22 June 2013, accessed 7 May 2017, https://www.offiziere.ch/?p=12488.

[49] Amos Fox and Andrew Rossow, "Making Sense of Russian Hybrid Warfare: A Brief Assessment of the Russo-Ukrainian War," *The Land Warfare Papers no. 112* (March 2017): 6-7.

[50] Dr. Phillip Karber, "Lessons Learned from the Russo-Ukrainian War: Personal Observations" (Historical Lessons Learned Workshop, Johns Hopkins Applied Physics Laboratory and U.S. Army Capabilities Center, Collaborative Analysis, Center, Laurel, MD, 8 July 2015), accessed 16 April 2017, https://prodev2go.files.wordpress.com/2015/10/rus-ukr-lessons-draft.pdf.

CHAPTER 3

RESEARCH METHODOLOGY

Overview

The purpose of this study was to identify possible solutions to bridge the ICM capability gap from 1 January 2019 until an ICM full replacement munition is in the inventory. During this study, effort was made to better understand the capabilities and limitations of the munitions that are currently available in the U.S. Field Artillery inventory through an unclassified document review of these munitions. During the time that ICM is unavailable and until the ICM full replacement capability is in the inventory, these were the munitions that will have to be utilized, from a land delivery aspect, during future conflicts where ICM would have been the munition of choice. To provide context for this research, an instrumental case study was conducted into the Russian aggression into Eastern Ukraine to determine the strengths and weaknesses of an adversarial force as they relate to the use of U.S. artillery to defeat. U.S. doctrine, organization, and materiel were then matched up against the strengths and weaknesses derived from the case study to determine if an overmatch exists and in whose favor. The results of the overmatch permitted an analysis within U.S. doctrine, organization, and materiel and provided recommendations for preparation and employment of the field artillery in combat situations without ICM.

Methodology

To answer the primary and secondary research questions posed in this study, an instrumental case study by way of a document review was utilized.[1] The primary research

question was: what should the U.S. Field Artillery do to bridge the capability gap between ICM and an ICM full replacement? The secondary research questions to be answered are: (1) what alternatives to ICM are currently in the U.S. Field Artillery inventory; (2) what are the current and future threats that require the U.S. Field Artillery to have an ICM like capability; (3) what changes to doctrine should be made in the absence of an artillery ICM munition; (4) what organizational changes should be made in the absence of an artillery ICM munition; and (5) what are the materiel changes or alternatives in the absence of an artillery ICM munition? The back drop for this study was the 2008 DoD Policy on Cluster Munitions and Unintended Harm to Civilians that caused the U.S. Field Artillery to lose a key munition in its inventory, ICM.

This study utilized a DOTMLPF-P theoretical framework and assessed whether an overmatch is present between the U.S. Field Artillery with the munitions currently in the inventory and Russian military demonstrated by their actions in Eastern Ukraine. The Russo-Ukrainian War as a case study was selected due to it being the most recent military engagement where both sides utilized armor formations, had robust air defense capabilities, and air superiority was contested. Additionally, this conflict occurred very near to North Atlantic Treaty Organization partner countries and should the conflict spread to one of those countries, the United States could find itself committed in their defense.

This case study will be used to provide insight to the effects the 2008 DoD Policy on Cluster Munitions and Unintended Harm to Civilians might have had on the U.S. Field Artillery's ability to provide lethal fires for the maneuver commander. The outcome of the overmatch analysis, if one existed, then formulated recommendations along the same

focused framework of doctrine, organization, and materiel, for what the U.S. Field Artillery can do or should continue to do to enable maneuver commanders in future warfare until the ICM full replacement munition enters the inventory. Doctrine, organization, and materiel were chosen as focus areas due to the ability to rapidly implement change. Training and leadership take longer to implement change and were not focused on during this study. Personnel and facilities are changed through the Total Army Analysis process and would years for implementation so they were not focused on during this study.

Data Collection

The public records, visual documents, and online data resourced to answer the research questions posed during this study spanned a wide array of sources from the DoD documents and policies; Army doctrine and data sheets; briefings and information papers from the Fort Sill, Oklahoma Fires Center of Excellence; other government agencies; and the private sector. This study specifically looked into the strengths and weaknesses of the munitions currently in the field artillery inventory, how the field artillery organize for combat, and doctrinally fight. To provide context of the potential ramifications of the 2008 DoD Policy on Cluster Munitions and Unintended Harm to Civilians, a case study on Russian military actions during the ongoing fight in Eastern Ukraine was conducted to determine an adversarial force's strengths and weaknesses along the same framework of doctrine, organization, and materiel to match up against that of the United States.

Data Analysis

The catalyst for analysis during this study was the perceived strengths and weaknesses of Russian military operations in Eastern Ukraine. The way in which the Russian military conducted land operations deriving strengths and weaknesses of their doctrine, organization for combat, and materiel. Some risk in analysis is being assumed on some of the Russian military's newer items of equipment such as the T-14 Armata Main Battle Tank as there is very little unclassified data to go on. Risk is assumed where Wikipedia is primary source of the system's full capabilities. From the study of Russian actions in Eastern Ukraine, perceived strengths and weaknesses were documented along the lines of doctrine, organization, and materiel utilized to conduct their operations.

Russian military strengths and weaknesses were then compared to the capabilities and limitations of U.S. artillery doctrine, organization, and materiel without the use of ICM in a chart to determine whether an overmatch exists and which side is in favor as well as determine if the U.S. Field Artillery will continue to be able to achieve the maneuver commander's desired effects. Within doctrine, the chart will compare the ability for artillery units to operate at the platoon level and mass fires as a brigade. Organization analyzed the number of field artillery units within a division size element as well as the number of systems within units from the battery to the division level. Materiel focused on the unclassified range achieved by the individual systems and the effects of different types of munitions available to those units. The outcome of the analysis will shape the recommendations for any suggested changes in U.S. Field Artillery doctrine, organization, and usage of already available munitions (materiel).

Possible Sources of Bias

The literary sources cited in the literature review and referenced throughout this study provide understanding of the problem this study is addressing as well as context to answer the research questions. The author is a serving U.S. Army Field Artillery officer that through schools and training has studied decisive action, stability, and contingency operations. The author has served on two deployments in Iraq (2007-2008, 2009) and one deployment in Afghanistan (2012) employing surface to surface and air to surface fires during two of those deployments. The author has not personally witnessed or directed the employment of ICM or other cluster munitions in combat or training exercises but through attending professional education at the Fort Sill Fires Center of Excellence, accounts from soldiers, pilots, and instructors, as well as through pictures and videos available on the internet has viewed the effects and capabilities these munitions can provide the maneuver commander. Additionally, the author's experience through attending the U.S. Army Command and General Staff College at Fort Leavenworth, Kansas, could have shaped the perception of the ongoing need for an ICM or ICM-like capability in the future.

There were external sources of bias outside of the author's control present during this study as well. This source of bias comes from the internet search engines and sources that were utilized and cited throughout this study. Bias from search engines like Google, Bing, Yahoo, and others, were presented in the form of sponsored links or articles that appeared in the top search results where news outlets or companies paid for their articles to be presented to the viewer first. The articles could then have presented the political

stance of the author or the news/publication agency in an attempt to influence public opinion and policy on the topic of study directly or indirectly.

Information, such as that found on Wikipedia, reference the full capabilities of the T-14 Armata Main Battle Tank should be met with skepticism until the world sees the system's true performance on the field of battle. These articles reinforced the reason this study is being conducted in the first place, the perceived need to change the way ICM affects the battlefield and more importantly, the civilians that are left to deal with the UXOs that remain when the fight is over or has moved. Undue civilian suffering was taken into account when assessing the military necessity for a munition like ICM as well as the munitions currently in the U.S. Field Artillery inventory that will be utilized to bridge the capability gap between ICM and an ICM full replacement.

Summary

An instrumental case study that utilized a document review that utilized DOTMLPF-P as an analytical framework was selected to answer the primary and secondary research questions. The Russo-Ukrainian War was utilized as the case study to determine an overmatch existed between the U.S. Field Artillery and the Russian military and if U.S. Field Artillery could continue to accomplish the maneuver commander's desired effects. Chapter 4 will describe in detail the Russo-Ukrainian War.

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[1] Merriam, 39-54, 139-163.

CHAPTER 4

ANALYSIS

Introduction

The purpose of this study was to identify possible solutions to bridge the ICM capability gap from 1 January 2019 until an ICM full replacement munition is in the inventory. Secondary research questions will be answered or further informed based off the case study and analysis of the Russo-Ukrainian War. These secondary questions include:

1. What are the current and future threats that require the U.S. Field Artillery to have an ICM like capability?
2. What changes to doctrine should be made in the absence of an artillery ICM munition?
3. What organizational changes should be made in the absence of an artillery ICM munition?
4. What are the materiel changes or alternatives in the absence of an artillery ICM munition?

This study analyzed unclassified documents that described actions taken by Russia leading up to and during the conflict in Eastern Ukraine. The information presented in the previous chapters and the additional context provided by the case study, attempted to inform the U.S. Field Artillery of potential changes that could be made in areas of doctrine, organization, and materiel. The following is a description of the Russo-Ukrainian War that served as the case for analysis for future U.S. Field Artillery actions.

The Russo-Ukrainian War Case Study

Background

The Russo-Ukrainian War served as a way for Russia to test and validate their new generation warfare (NGW) doctrine as well as new or upgraded equipment. NGW focused on what Russia perceived to be Western weaknesses through the five components that made up NGW: political subversion; proxy sanctuary; intervention; coercive deterrence; and negotiated manipulation.[1] Russia's NGW was a part of a policy known as *maskirovka*, (camouflage). The aim of *maskirovka* was to mislead the enemy's knowledge of Russian plans, troop presence, disposition, readiness, and operations. Russian special operations played a major role in their operations in Crimea and the Donbas through deception tactics that made war look like peace.[2]

This is the first war where both sides had access to unmanned aerial systems (UAS). Russia utilized quadcopters and fixed wing UAS of various forms to aid in target identification, reconnaissance,[3] and to conduct battle damage assessments.[4] UAS were also used as a psychological weapon by flying over troop concentrations and due to their small size were difficult to detect until directly overhead. Often linked to the UAS were artillery units. Artillery has accounted for 80[5] to 85 percent of all casualties on both sides during the conflict.[6] Russian artillery units employed DPICM, family of scatterable mines, top-attack munitions, and thermobaric warheads singularly as well as together and achieved catastrophic effects[7] that focused on mass, not precision.[8]

The conflict continued throughout the course of this study with little in the way of change to the front lines. Accusations of ceasefire violations and volleys of fire continue to be traded along with relatively small amounts of land by both sides.

Crisis in Kiev (November 2013-February 2014)

Ukraine was in pursuit of greater integration with the European Union through association and free trade agreements until 23 November 2013 when President Viktor Yanukovych ended the talks. The Ukrainian government had been under considerable pressure from the Russian government to end talks with the European Union. President Yanukovych traveled to meet with Russian President Vladimir Putin and secured a $15 billion loan through the sale of Ukrainian Eurobonds to keep the Ukrainian economy afloat as well as a 33 percent reduction in the price of natural gas. Nearly one million people gathered in protest at Independence Square in Kiev. Protesters took over government buildings and blocked city streets while they called for Yanukovych, the prime minister, and the cabinet to resign.

In February 2014, opposition leaders met with Yanukovych and negotiated an amnesty deal for the protesters to leave the streets. Less than one week later, protesters clashed with police due to parliament stalling to restore the 2004 constitution; this resulted in more than 100 people killed. Yanukovych met with opposition leaders in a meeting that was mediated by France, Germany, Poland, and Russia. The meeting resulted in an agreement to hold elections by the end of the year, establish a national unity government, and Ukraine would return to its 2004 constitution. All parties signed the agreement except for Russia. Militant protesters continued to call for Yanukovych's resignation.[9] Yanukovych fled Kiev for Kharkiv in Eastern Ukraine and was impeached by parliament. Speaker of the House, Oleksander Turchynov, was appointed to be the interim president and a new parliament was in place by the end of February. Governmental leaders in the Donbas as well as Crimea continued to pledge

their support to Yanukovych vice the interim government.[10] No military action occurred in these beginning stages of the conflict.

Annexation of Crimea (February-March 2014)

Long before trouble emerged in Ukraine, Russian operatives and special forces were at work in Crimea. They created a pro-Russian environment well before 2014. Oligarchs were paid off, local officials were bribed, and pro-Russian propaganda was circulated that enabled popular support and cooperation.[11] After Yanukovych was impeached, protesters took to the streets and demanded greater autonomy from Ukraine and closer ties to Russia.[12] Berkut special police units, units that were officially dissolved on 25 February 2014 by the Ukrainian Parliament, seized checkpoints between Crimea and mainland Ukraine on 27 February.[13] Protesters stormed government buildings and removed the Ukrainian flags from them. Hundreds of unmarked men in military uniforms with military equipment, seized the airports in Sevastopol and Simferopol as well as television stations[14] while what was believed to have been Russian special forces occupied the Crimean Parliament.[15]

The Russian Ambassador to the United Nations assured the international community that any Russian troop movement in Crimea was within the lease agreement for the port in Sevastopol[16] as well as produced a photocopy of a letter from Yanukovych from 1 March that requested President Putin to use armed forces to restore peace, stability, rule of law, and protection of the population of Ukraine. The Russian Parliament officially authorized Putin to utilize the Russian military in Crimea.[17] A referendum to join the Russian Federation was voted on by the population of Crimea where 96.8 percent of the voters supported the action. Crimea officially became part of the Russian

Federation on 21 March when Putin signed the law for annexation.[18] In a span of three weeks, Russia employed nearly 10,000 troops consisting of special forces, naval infantry, and other specialized battalions in what appeared to be a humanitarian mission that never fired a single shot and annexed Crimea.[19]

Battle in the Donbas (April-September 2014)

Following the annexation of Crimea, protests began in cities throughout the Donbas. Rebels in the region seized government buildings as well as police and security stations in the major cities. By 7 April, the Donetsk People's Republic and the Luhansk People's Republic were formed and both requested Putin to send peacekeeping forces to Eastern Ukraine. Ukrainian forces started anti-terrorist operations to disarm illegal groups throughout the Donbas. Petro Poroshenko was elected president of Ukraine and took office in June.[20]

In July, two Ukrainian mechanized battalions were rendered combat ineffective in less than three minutes when struck by Russian rockets[21] at Zelenopillya. The strike utilized DPICM, scatterable mines, and thermobaric warheads that devastated the battalions.[22] Malaysian Airlines flight 17 was shot down over Eastern Ukraine on 17 July 2014 by a BUK-1M SAM fired from rebel controlled territory that killed all 295 people on board. The investigation took more than two years to complete due to heavy fighting in the area of the crash site.

In August, the International Committee of the Red Cross assembled countries to provide aid to Eastern Ukraine, one of which was Russia. The 280 semi-truck Russian convoy that carried 2,000 metric tons believed to be food, supplies, and medicine diverted from the agreed upon entry point to one controlled by Russian forces and entered

Ukraine. Only 220 of the 280 trucks returned to Russia. Throughout the conflict, Russia had been massing troops and equipment along the Ukrainian border and in Crimea. Russian forces crossed into Ukraine in early September and engaged Ukrainian troops with tanks and artillery at the Luhansk airport forcing their withdrawal. Presidents Poroshenko and Putin met in Minsk, Belarus to put an end to the hostilities.[23]

Minsk I Ceasefire (September 2014-January 2015)

The meeting between the two presidents resulted to a ceasefire with the following terms: halt all offensive operations; Ukrainian troops will move back their artillery; Ukraine will cease airstrikes; establish an international monitoring mission; establish humanitarian corridors; all prisoners will be exchanged; and repair damaged infrastructure. The ceasefire was to take effect on the evening of 5 September. The ceasefire held throughout the Donbas except for in Mariupol. Pro-Russian rebels continued to advance supported by tanks and artillery. In the weeks that followed, the ceasefire continued to deteriorate with rebels gaining ground throughout the region. Their advances were preceded by heavy rocket and artillery fire with the heaviest of fighting occurring at the Donetsk airport.

In late October, rebels declared an end to the ceasefire and vowed to retake the major cities throughout the Donbas.[24] Human Rights Watch documented the use of cluster munitions in more than a dozen locations throughout Donetsk and Luhansk.[25] Russia continued the build-up of troops along the border with Ukraine. International observers from the Organization for Security and Cooperation in Europe reported Russian cargo trucks crossing the border back into Russia in mid-November. The trucks bore the marking Cargo 200, which is Russian, code for soldiers killed in action.

A Day of Silence was declared between the rebels and Ukrainian forces on 9 December in a show of good faith for further peace negotiations scheduled to take place in the coming weeks. Approximately 375 prisoners were exchanged on 26 December between the rebels and Ukrainian forces. The new year brought with it renewed fighting after Security Services of Ukraine operatives killed a pro-Russian militia leader. By late January, a state of emergency was declared as rebels continued to gain ground. Ukrainian positions were subjected to heavy shelling by rockets throughout the region and a new front was opened around Mariupol.[26]

Minsk II (February 2015-Present)

The second Minsk ceasefire was scheduled to go into effect on 15 February. Rebels were on the offensive to seize as much ground as possible prior to the ceasefire and the fiercest fighting occurred in Debaltseve. Russia deployed massive amounts of artillery and MRLs and shelled Ukrainian positions to ensure that the rebels captured the large railroad interchange prior to the ceasefire. Once the ceasefire took effect, fighting continued in Debaltseve as well as spread to Mariupol. Multiple agencies reported that cluster munitions had been used in the several cities throughout the Donetsk region.[27] By late February, the ceasefire was generally holding and both the rebels and Ukrainians began to pull larger weapons away from the line of contact.

The next few years saw several periods of renewed and heavy fighting as well as times of relative peace where progress was made toward full implementation of the Minsk II ceasefire agreement. The United Nations released a report in April 2016 that estimated more than 9,333 people had died and another 21,396 had been wounded in the

conflict. By September 2016 rebels stated they were fully committed to the Minsk II ceasefire as that was the only way to resolve the conflict.

Evidence of Russian forces involvement in the conflict continued to surface. In October 2016, a former separatist finance minister stated that Russia was directly financing pensions and public sector salaries in the Donbas due to funding being cut from Kiev. A report from the United Nations International Criminal Court released in November 2016 cited Russia for instigation of the war in Ukraine. The report stated that international armed conflict began no later than 26 February 2014 when Russia employed members of its armed forces in Ukraine to gain control over parts of the country without the government's consent. January 2017 brought little change to the conflict with violence continuing to increase yet again and both sides blaming the other for instigation and violations of the Minsk II ceasefire.[28]

Analysis

Doctrine

The primary difference between the U.S. and Russian artillery was the focus on precision versus mass respectively.[29] Precision versus mass does not necessarily have a direct correlation to a tactical advantage, but precision does have an operational and strategic advantage in the form of supply. Precisely targeted entities utilized fewer rounds than targets where mass is utilized. The issue with precision was how precisely the target was located. U.S. and Russian artillery had the ability to mass artillery fires at the division level. The United States had an advantage due to operations as platoons that occupied PAAs where Russia generally kept the battery together. Dispersion allowed the U.S. artillery units a better chance to survive and forced the adversary to acquire multiple

targets, process multiple fire missions simultaneously, and potentially split the unit designated to deliver counterfire.

Russian doctrine has placed emphasis on counterbattery radars[30] and counterfire to not necessarily destroy enemy equipment but to disrupt the fire mission and cause them to move.[31] BTGs dispersed due to increased lethality in the Donbas and occupied the space typical of a Cold War era brigade.[32] Russia utilized multiple sensors that varied in size and altitude to detect targets along their planned flight path in the Donbas and then delivered massive artillery strikes within 15 minutes.[33] Dr. Phillip Karber witnessed these tactics in September 2014 and June 2015. UAS identified targets in both instances which were struck by BM-21s. The UAS would then return to the target area and conduct a battle damage assessment.[34]

The Russian system seems to mirror the U.S. model of decide, detect, deliver, and assess. The area of operation would be decided upon with UAS flight routes planned. UAS flew the planned routes and attempted to detect targets which were then struck by BM-21s or BM-30s. The UAS would return to the location of the strike and assess the effectiveness of the strike and allowed the commander to determine if a reattack was necessary. Russia modified their doctrinal employment of howitzers by utilizing them in a planned direct fire role known as an assault gun. The howitzers were utilized to target Ukrainian strong points, suppress ATGM teams,[35] or in an anti-tank role themselves.[36] This change resulted in their overwatch range being extended from 5,000 meters from a tank main gun to 6,000 meters. The change resulted in Ukrainian anti-tank teams being reluctant to open fire on Russian armored personnel carriers or armor for fear of being targeted by direct fire artillery. The disadvantage of this tactic was due to the lack of

armor on some artillery systems and light armor of self-propelled systems. Direct fire engagements generally resulted in very high loss rates.[37] The U.S. artillery is trained in direct fire but not in an overwatch role for maneuver forces.

Russia incorporated electronic warfare (EW) in the BTG for target detection as well as protection. Self-propelled EW vehicles with targetable jammers were utilized to break GPS links and crash the UAS.[38] Other EW systems were utilized to deny communications, defeat artillery and mortar rounds with electronic fuzing causing them to pre-detonate or dud, and target command and control nodes by detecting their electromagnetic signature. When a command node was detected, UAS would refine the location and massed rocket artillery would strike.[39] The introduction of EW assets to deny utilization of GPS signals and pre-detonate or dud rounds with electronic fuzing could cause problems for the United States in the utilization of Excalibur. The presence of EW assets could result in the U.S. artillery being required to resort to the utilization of HE munitions. EW assets could be a difficult target to pin-point and would require the utilization of massive amounts of HE rounds where much fewer ICM rounds could be utilized to saturate the area and suppress or degrade Russia's EW capability. Table 3 summarizes the comparison of U.S. and Russian artillery employment.

Table 3. Doctrinal Comparison of United States and Russia

		U.S.	Russia	Advantage
Doctrine	Ability to operate at platoon level	X		U.S.
	Ability to mass as a division	X	X	None
	Incorporates UAS for FA targeting		X	Russia
	FA utilized in direct fire mode	X	X	Russia
	Emphasis on precision	X		
	Emphasis on area fire		X	
	Integrated EW assets at battalion		X	Russia

Source: Created by author.

The United States gained the advantage to operate down to the platoon level which allowed for units to be more dispersed and increase survivability while still being able to mass fires if needed. Both the United States and Russia had the ability to mass at the division level if necessary but Russia had the advantage due to more artillery systems contained within its organizations. Russia continued to have the advantage when it came to UAS for targeting due to UAS platforms being directly linked and utilized for target development and battle damage assessment in support of artillery systems. Both the United States and Russia had the ability for cannon artillery to be utilized in a direct fire role, however, Russia earned the advantage by extending the BTG's AT range out to 6,000 meters through the use of cannon artillery in a direct fire role to suppress ATGM positions and as an anti-tank platform. Russian BTGs with EW capability are another advantage over the United States. They denied the use of electronic fuzes, munitions that depended on a GPS link, and the use of UAS for reconnaissance. Russia's EW capability

negated any advantage for the United States from use of precision munitions such as Excalibur, GMLRS, and GMLRS-AW. This was due to Russia's capability to interrupt the satellite link and the possibility of making the munitions dud or pre-detonate. Overall, Russia had the doctrinal advantage over the United States.

Organization

Both U.S. and Russian cannon artillery battalions are organized into three batteries of six howitzers. U.S. rocket artillery batteries have two more launchers than Russian batteries. Russians have the advantage at the battalion level as there are three batteries to the two U.S. batteries with a total difference of two launchers. This organizational difference allows the Russians to directly support each of the maneuver battalions in the brigade with rockets. Where the United States has one cannon battalion per brigade, a Russian brigade has two cannon battalions and a rocket battalion. The difference in organization gave a Russian brigade a three to one size advantage over a U.S. BCT.

The Russian advantage is continued due to the decentralization of artillery batteries down to maneuver battalions[40] where two to four batteries of cannons and rockets can be placed in direct support. U.S. battalions could be given an entire cannon battalion in support of their operation but only for a limited duration. Russia utilized an on-call rocket delivery system that could quickly respond to targets identified by UAS in the Donbas producing devastating effects with DPICM, top-attack munitions, and thermobaric warheads.[41]

This system of UAS targeting was illustrated best during the case study by the rocket barrage in July 2014 that decimated two Ukrainian mechanized battalions in three

minutes. U.S. artillery could not have replicated an attack of this magnitude due to the loss of ICM. Platoon targets where ICM would have been the munition of choice, would have to be executed by no less than a battery that fired multiple volleys of HE munitions and increased the probability of detection. Without ICM, battery targets would have to have been serviced by battalions and battalion targets serviced by DIVARTY.

The increased expenditure of munitions by larger units firing more missions could resulted in a strained supply system as well as targets not being serviced by indirect fires. The aspect of support was an advantage for the United States that could have allowed for longer sustained operations due to a FSC located in each artillery battalion and a BSB to support the BCT. A Russian brigade and its subordinate battalions could potentially suffer from a supply shortfall due to a lack of sustainment assets. Russia had a materiel support battalion within the brigade but only three transport companies to support 14 battalions and four other companies. Targeting of the Russian transport companies could yield superior results due to their limited numbers and change the way in which the BTGs are dispersed as well as how they fight. Table 4 summarizes the comparison of U.S. and Russian artillery organizations.

Table 4. Organizational Comparison of United States and Russia

		U.S.	Russia	Advantage
Organization	Tubes per battery	6	6	None
	Tubes per battalion	18	18	None
	Tubes per brigade/BCT	18	36	Russia
	Launchers per battery	8	6	U.S.
	Launchers per battalion	16	18	Russia
	Launchers per brigade/BCT	0	18	Russia
	Support battalion at brigade level	X	X	None
	FSC located in battalion	X		U.S.

Source: Created by author.

An organizational advantage up to the cannon artillery battalion organization did not exist due to equal number of howitzers. Russia clearly had the advantage at the brigade level due to having double the number of cannon artillery assets as well as rocket artillery assets. The United States had more launchers in a battery but the advantage went back to the Russians at the battalion level. More total number of launchers existed in a Russian rocket battalion and they were organized into three batteries that afforded a battery to support each BTG in the brigade. The United States typically does not commit a rocket battalion to directly support a brigade unless for a very specific, short term mission. Both the United States and Russia had support battalions at the brigade level as well as a total of three distribution company size elements within the brigade. Russian transportation companies provide supplies for 14 total battalions as well as four other companies where the United States had a distribution platoon directly supporting a battalion. Due to the Russians are required to move twice the amount of materiel to sustain the brigade, the United States gained the advantage. The range capability gap

would be closed with the introduction of extended range howitzers for Stryker BCTs and Armor BCTs but Infantry BCTs would remain lacking due to only having one battery of M777. Russia had the overall organizational advantage, but their distribution companies were also their critical vulnerability.

Materiel

Russia employed DPICM, top-attack munitions, and thermobaric warheads in the Donbas that resulted in devastating effects achieved against Ukrainian forces. Cannon and rocket artillery produced 80 to 85 percent of the casualties in the Russo-Ukrainian War. While Russia continued production and maintenance of their DPICM stockpiles, the United States had begun to convert its stockpiles into lower cost training munitions. Although ICM was no longer available for use, the United States introduced the GMLRS-AW to begin filling the capability gap left behind. GMLRS-AW was effective against some targets but the United States continued to lack an effective anti-armor indirect fire munition.

Additional munitions were being developed to meet the anti-armor requirement such as the SMArt 155 and HRDR munitions. Sensor fuzed munitions such as SMArt 155 are great against light and heavy armored targets, but useless against soft targets and targets that required suppression.[42] HRDR would be effective against soft, semi-soft, and hard targets and when used for suppression[43] while meeting the reliability standards set forth in the DoD policy.

Tanks in the Donbas were deployed with ERA and some deployed with APS. Both the SMArt 155 and HRDR could experience difficulties penetrating ERA and APS, but HRDR could have a higher potential to have produced a mobility or firepower kill

with the numerous submunitions. HRDR would have placed effects on any dismounted personnel near the target where SMArt 155 on its own would not and would have required an additional type of munitions such as GMLRS-AW to be shot in conjunction with it. The additional type of munitions required to be shot with the SMArt 155, would not alleviate the strain on the support units and a change to the MTOE could be needed.

Russian artillery outranged U.S. artillery in both cannon and rocket units. The BM-21 cannot outrange GMLRS, but the BM-30 could. The Russian D-30 outranged the M119 by more than 2,000 meters, 2S19 outranged M777 and M109 by 15,000 meters. U.S. BCTs do not have an asset that can provide counterfire capability out to the maximum range of Russian cannon units. However, even if a decision was made to task organize MLRS or HIMARS to BCTs, the BM-30 would outrange them by 20 kilometers. Table 5 summarizes the comparison of U.S. and Russian cannon and rocket artillery ranges and their respective munitions available.

Table 5. Materiel Comparison of United States and Russia

		U.S.	Russia	Advantage
Range	Light Howitzer	19,500	21,900	Russia
	Medium Howitzer	30,000	45,000	Russia
	Rocket	70,000	90,000	Russia
Munitions Available	HE	X	X	Russia
	DPICM		X	
	Tungsten Ball	X		
	Sensor Fuzed Munition		X	
	Thermobaric		X	
	GPS	X		

Source: Created by author.

The U.S. cannon artillery units were clearly outranged by the Russians in both light and medium howitzers. The Russian BM-21's range was more than doubled by the U.S. MLRS and HIMARS, but the BM-30 outranged U.S. rockets by 20,000 meters giving them a range advantage. Russia and the United States had HE munitions available, but the Russians had a variety of other artillery munitions available such as DPICM, sensor-fuzed munitions, and thermobaric warheads that were shown to have had devastating effects on large formations such as those in the three-minute barrage at Zelenopillya. The United States does not have the capability to match the lethality demonstrated in the attack at Zelenopillya and gave the munitions available advantage to Russia. Even with the introduction of extended range howitzers, the requirement for additional HE ammunition due to the loss of ICM remains. Russia gained the overall materiel advantage through range and munitions available.

Summary

Russia portrayed themselves as a potential threat due to their actions in Ukraine and proximity to North Atlantic Treaty Organization allies. In a fight against Russia, the United States would need the capabilities of ICM due to targets with greater dispersion, presence of EW assets that could deny GPS and pre-detonate or dud munitions with electronic fuzes, and have effects on the most target types with one munition. U.S. artillery units will be required to shoot and quickly displace to another location to avoid being struck by counterfire. BCTs will be required to have MLRS or HIMARS to effectively conduct counterfire operations as well as additional cannon units due to the increased number of munitions required to have achieved the commander's desired

effects. The increased number of rounds needed per target could necessitate a future change to the FSC and BSB MTOEs to move the additional munitions.

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[1] Phillip Karber and Joshua Thibeault, "Russia's New Generation Warfare," Association of the United States Army, 20 May 2016, accessed 9 April 2017, https://www.ausa.org/articles/russia%E2%80%99s-new-generation-warfare.

[2] Nicholas Fedyk, "Russian "New Generation" Warfare: Theory, Practice, and Lessons for U.S. Strategists," *Small Wars Journal* (25 August 2016): 1, accessed 7 April 2017, http://smallwarsjournal.com/jrnl/art/russian-%E2%80%9Cnew-generation%E2%80%9D-warfare-theory-practice-and-lessons-for-us-strategists.

[3] Karber and Thibeault.

[4] Karber.

[5] Karber and Thibeault.

[6] Karber, 17.

[7] Karber and Thibeault.

[8] Karber, 13.

[9] Center for Strategic International Studies, "The Ukraine Crisis Timeline, Crisis in Kyiv," 23 February 2014, accessed 19 April 2017, http://ukraine.csis.org/kyiv.htm.

[10] Wikipedia, "Russian Military Intervention in Ukraine (2014–Present)," Wikipedia Foundation, last modified 30 April 2017, accessed 30 April 2017, https://en.wikipedia.org/wiki/Russian_military_intervention_in_Ukraine_(2014%E2%80%93present)#Background.

[11] Fedyk.

[12] Center for Strategic and International Studies (CSIS), "The Ukrainian Crisis Timeline, Annexation of Crimea," 19 March 2014, accessed 19 April 2017, http://ukraine.csis.org/crimea.htm.

[13] Wikipedia, "Russian Military Intervention in Ukraine (2014–Present)."

[14] CSIS, "The Ukrainian Crisis Timeline, Annexation of Crimea."

[15] Wikipedia, "Russian Military Intervention in Ukraine (2014–Present)."

[16] CSIS, “The Ukrainian Crisis Timeline, Annexation of Crimea.”

[17] Wikipedia, “Russian Military Intervention in Ukraine (2014–Present).”

[18] CSIS, “The Ukrainian Crisis Timeline, Annexation of Crimea.”

[19] Fedyk.

[20] CSIS, “The Ukrainian Crisis Timeline, Annexation of Crimea.”

[21] Karber, 18.

[22] Peter Doran, *Land Warfare in Europe, Lessons and Recommendations from the War in Ukraine* (Washington, DC: Center for European Policy Analysis, November 2016), accessed 30 May 2017, https://cepa.ecms.pl/files/?id_plik=2991, 4.

[23] Center for Strategic and International Studies, “The Ukraine Crisis Timeline, Downing of MH17,” 4 September 2014, accessed 1 May 2017, http://ukraine.csis.org/mh17.htm.

[24] Ibid.

[25] Nick Cumming-Bruce, Katherine Harrison, Lucy Pinches, and Stuart Casey-Maslen, *Clearing Cluster Munition Remnants 2016* (A Report by Mine Action Review for the Sixth Meeting of State Parties to the Convention on Cluster Munitions, Oslo, Norway: Norwegian People’s Aid, 2016), accessed 30 May 2017, https://mine.gov.hr/UserDocsImages//arhiva/files//Clearing_Cluster_Munition_Remnants_2016_WEB.pdf, 119.

[26] Center for Strategic and International Studies, “The Ukraine Crisis Timeline, Elections in Ukraine,” 10 February 2015, accessed 1 May 2017, http://ukraine.csis.org/elections_ukr.htm.

[27] Cumming-Bruce et al., 119.

[28] Center for Strategic and International Studies, “The Ukraine Crisis Timeline, Minsk II to Present,” 1 February 2017, accessed 3 May 2017, http://ukraine.csis.org/index.htm.

[29] Karber, 13.

[30] Ibid., 21.

[31] Karber and Thibeault.

[32] Karber, 20.

[33] Ibid., 12-13.

[34] Ibid., 13.

[35] Ibid., 19.

[36] Karber and Thibeault.

[37] Karber, 19.

[38] Ibid., 15.

[39] Karber and Thibeault.

[40] Karber, 19.

[41] Ibid., 13.

[42] Dullum, 143.

[43] Ibid.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Can the U.S. Field Artillery bridge the capability gap between January 2019 and an ICM replacement? Yes, the U.S. Field Artillery can bridge the capability gap with the doctrine, organization, and materiel currently available. Doctrine, organization, and materiel were chosen as focus areas for this study due to the ability to rapidly implement change. Training and leadership were not focused on due to additional time needed to implement change in these areas. Personnel and facilities are changed through the Total Army Analysis process and would take years for implementation so they were not focused on during this study. There will be some logistical challenges to overcome in the process. This problem in missing capability can be successfully met with increases in maneuver space, assets to support BCTs, and munitions currently available in the inventory.

What current and future threats require the U.S. Field Artillery to have an ICM like capability? Russia has established themselves as a threat to European countries through their overt and covert actions in Eastern Ukraine. Many of the European countries are also members of the North Atlantic Treaty Organization and could seek assistance from the United States should Russia attack them. Russia possesses the capability to disrupt GPS operations making precision targeting more difficult. With larger error in target location, the use of area effects munitions will allow for quicker effects on the target and less rounds expended in the process. Mechanical versus electronic fuzing will be critical due to Russia's ability to dud or pre-detonate electronic

fuzes. The range of supporting arms such as artillery as well as Russian doctrine allows for maneuver elements to have greater dispersion requiring munitions that can cover larger areas or munitions that can independently find and target them. Although this study focused solely on Russia as a competitor, there are other peer or near peer competitors such as China and the Democratic People's Republic of Korea.

Should changes to doctrine be made in the absence of an artillery ICM munition? Yes, changes to doctrine will be necessary. Due to alternative munitions being less effective than ICM, a larger unit will have to be utilized to mass or smaller units will have to shoot more volleys. Additional volleys being fired increase the probability of detection and risk of counterfire. PAAs are a control measure that artillery units are assigned to operate and survive within. To avoid detection and counterfire, artillery units will have to move following each fire mission and following UAS overflights. Counterfire and presence of UAS will cause artillery units to be constantly moving and hiding to ensure their survivability in a fight against Russia. Constant movements as well as the increased lethality associated with UAS supported by artillery in the Donbas will drive U.S. Field Artillery units to require additional space to operate and survive in future conflict.

Should changes to organization be made in the absence of an artillery ICM munition? Organizational MTOEs should not be changed until a replacement for the ICM munition is decided on. A change to the MTOE for the bridging solution would be irresponsible due to the potentially short duration of the change.

What should change is the task organization for combat. BCTs need additional howitzers to fire the increased number of rounds needed due to no longer having ICM

available. Additional howitzer tubes allow for larger quantities of massed fires, fewer volleys that results in decreased probability of detection and greater chances for survivability. Due to U.S. field artillery cannons being outranged by the Russian systems, BCTs will need the ability to conduct counterfire beyond the range of their organic artillery battalions. MLRS and HIMARS are a viable option to give BCT commanders additional flexibility with their cannon battalion and disrupt adversary artillery attacks beyond a BCT's organic cannon battalion range. The deployment of additional cannon battalions as well as MLRS and HIMARS units is not sustainable over the long term due to the current size of the artillery force. Should this option be implemented as a long-term solution, the artillery force would need to grow significantly in terms of personnel and equipment to be sustainable.

Extended range cannon artillery tubes were being developed and tested during the course of this study. MLRS and HIMARS was the only way to extend the range of BCTs to meet or exceed those of Russian cannon artillery units. Once the extended range cannon artillery tubes are fielded, the requirement for MLRS and HIMARS can be reduced. Cannon artillery with extended range still does not affect the requirement for larger quantities of munitions needed to achieve similar effects as ICM.

Are there materiel changes or alternatives that could be used in the absence of an artillery ICM munition? Alternative munitions to ICM exist in the U.S. Field Artillery inventory. These munitions range from standard HE to Excalibur, GMLRS, and GMLRS-AW. None of these munitions are a direct replacement for ICM and would require multiple volleys to achieve the same effects as ICM which increases exposure,

probability of detection, and risk of counterfire. Changes to materiel are in the works with SMArt 155 and HRDR under consideration.

SMArt 155 is a viable option as an anti-armor munition but would require another munition such as GMLRS-AW or HE to be employed on the same target to have effects similar to ICM. The need for additional types of munitions to achieve effects similar to those generated by ICM does not help alleviate the supply and distribution problem from larger quantities of ammunition required due to the lack of ICM. Two submunitions that seek out and kill a maximum of two targets are deployed from one SMArt 155 munition compared to one ICM round that could potentially affect as many target as could fit within the dispersion pattern of the submunitions. SMArt 155 could potentially require an organizational change due to the munition's inability to attack soft targets and provide suppression. The organizational change could be increasing the size of the existing batteries or even the creation of another battery within the battalions to enable additional munitions to be fired in conjunction with SMArt 155. Large armor formations would require multiple volleys of SMArt 155 again increasing probability of detection and risk of counterfire.

HRDR is simply an upgraded version of ICM that would meet the reliability standard of no more than 1 percent UXO as set forth by the DoD policy letter. ICM and HRDR would be able to affect the same target sets as well as be utilized for suppression where SMArt 155 could not. HRDR could be utilized with the current size of the artillery force with little to no change in the organization due to the ability to attack soft, semi-soft, and hard targets as well as be utilized as a suppression munition. Even with the

alternative munitions in the inventory and new munitions on the horizon, U.S. cannon and rocket artillery remain outranged by similar Russian systems.

Recommendations

1. Focus of new munition development should be on HRDR. HRDR will eliminate the need to utilize multiple types of munitions on targets and reduce strain on support units that move materiel.
2. BCTs training for conventional operations against a near-peer or peer competitor should be augmented with an additional cannon artillery battalion and a MLRS or HIMARS battery for training and the deployment. This will allow for larger firing elements to mass with munitions other than ICM and provide a counterfire capability beyond the range of a BCT's organic fires battalion. Augmentation during training would allow time for refinement of systems and processes as well as BCTs to train as they would fight.
3. The planned size and numbers of PAAs should be increased. Larger PAAs will allow artillery units more space to move and survive in combat. More PAAs will allow artillery units more options to best provide the BCT with fires as well as more locations to move following UAS overflight.

Additional Research

Time constraints and classification of this document limited this study to qualitative analysis of bridging the capability gap between January 2019 and an ICM replacement. This unclassified case study of the Russo-Ukrainian War and capability match up along the theoretical framework of doctrine, organization, and materiel

provides a way to bridge the ICM capability gap until the replacement munition is in the inventory. A future area of study could analyze the new munitions and how they could be employed in a manner that reduces the strain on the supply systems and support units within the military. This analysis could lead to a conclusion that the vehicles within the support units or flat racks need to be modified or changed altogether.

Another area for future study is the communications linkages between the forward observers and the fire direction centers or fire support cells within the units. As ranges of the systems increase and units are able to have greater dispersion, the range and reliability of the communications systems should also increase. The study could research the viability of high frequency radios on the modern, fast-paced battlefield as well as other networks types such as the different tactical wave form radios or satellite communications.

A final area of consideration for additional study would by the organization and equipment utilized by artillery battalion FSCs. When the replacement for ICM becomes available, will the FSCs have the necessary capability and capacity to move the munitions as well as all other classes of supply? The study could determine if the number of personnel and vehicles are sufficient to move all classes of supply in a timely manner to the artillery battalion or if more people or a new vehicle are necessary.

Secondary conclusions surfaced that were outside the scope of this study that have implications for the Army as a whole and warrant further study. BCTs and battalions have EW personnel within the organization but do not have EW organic assets to produce effects. EW effects have to be requested from outside the unit and are not always readily available to commanders to protect the force, disrupt the enemy's decision cycle, and

disrupt, deny, or degrade their ability to communicate. Another aspect to this study is how the EW environment affects mission command as a philosophy as well as the systems. This study could analyze the EW capabilities and equipment needed by battalion and brigade commanders to dominate the enemy's decision cycle through limited or denied ability to communicate; size of the U.S. digital and electromagnetic footprint; and methods to reduce their size to protect the force while enabling mission command.

Russia displayed an extensive use of UAS in the Donbas that enabled targeting with massed artillery. The United States has little to no capability to detect or deny the use of UAS other than sight and sound. These systems present a major threat to U.S. operations in the future as they become smaller, quieter, payloads of sensors and weapons increase in capability, and their use becomes more wide spread. This study could analyze counter UAS systems and procedures being utilized by allied nations to determine recommended tactics, techniques, and procedures for conducting operations in an environment with UAS presence to be implemented by the war fighting functions.

The final secondary conclusion was that changes will need to be made in the way the United States conducts mission command. The last 15 years of war and addition of physical systems have made command post quite large and immobile. Their current size, structure, and mobility would present a rather easy target for a peer or near-peer competitor to detect, target, and destroy. Possible areas to consider are the size and composition of mission command nodes at the battalion and brigade levels. How do they array and position themselves to provide mission command to the force as well as maintain the ability to collaborate? When would they come together at a single location and for what purpose without being targeted? How big is the digital and electromagnetic

footprint and what are ways to mitigate their size without degrading mission command capability? How does a battalion or BCT then do this in an EW environment or a degraded, denied, and disrupted space operating environment? The present day operating environment is far too lethal for the United States to conduct mission command the same way it has in the most recent conflicts.

BIBLIOGRAPHY

Books

Merriam, Sharan B. *Qualitative Research: A Guide to Design and Implementation.* 3rd ed. San Francisco, CA: Jossey-Bass, 2009.

Government Documents

Headquarters, Department of the Army. Army Doctrine Reference Publication 3-09, *Fires*. Washington, DC: Government Printing Office, 2012.

_____. Army Technical Publication 3-09.23, *Field Artillery Cannon Battalion*. Washington, DC: Government Printing Office, 2015.

_____. Army Technical Publication 3-09.42, *Fire Support for the Brigade Combat Team.* Washington, DC: Government Printing Office, 2016.

_____. Army Technical Publication 4-90, *Brigade Support Battalion*. Washington, DC: Government Printing Office, 2014.

_____. Field Manual 3-09, *Field Artillery Operations and Fire Support*. Washington, DC: Government Printing Office, 2014.

_____. Field Manual 3-96, *The Brigade Combat Team*. Washington, DC: Government Printing Office, 2015.

_____. Field Manual 6-30, *Tactics, Techniques, and Procedures for Observed Fire*. Washington, DC: Government Printing Office, 1991.

_____. Technical Manual 43-0001-28, *Army Ammunition Data Sheets Artillery Ammunition Guns, Howitzers, Mortars, Recoilless Rifles, Grenade Launchers, and Artillery Fuzes.* Washington, DC: Government Printing Office, 1994.

Office of the Director, Operational Test and Evaluation. "Excalibur Increment 1b M982E1." *FY14 Army Programs,* 107-108. Washington, DC: Operational Test and Evaluation, January 2015. Accessed 31 March 2017. http://www.dote.osd.mil/pub/reports/FY2014/pdf/army/2014excalibur_xm92.pdf.

_____. "Excalibur XM982 Precision Engagement Projectiles." *Army Programs,* 59-60. Washington, DC: Operational Test and Evaluation, January 2009. Accessed 31 March 2017. http://www.dote.osd.mil/pub/reports/FY2008/pdf/army/2008excalibur.pdf.

_____. “Guided Multiple Launch Rocket System - Alternate Warhead (GMLRS-AW) XM30E1.” *FY 14 Army Programs,* 109-110. Washington, DC: January 2015. Accessed 14 November 2016. http://www.dote.osd.mil/pub/reports/FY2014/pdf/army/2014gmlrs.pdf.

Secretary of Defense. Memorandum, “DoD Policy on Cluster Munitions and Unintended Harm to Civilians.” Washington, DC: Department of Defense, 19 June 2008.

U.S. Army Training and Doctrine Command Intelligence Support Activity. *Worldwide Equipment Guide Volume 1: Ground Systems*. Fort Leavenworth: U.S. Army Training and Doctrine Command G-2, 2011.

Journals/Periodicals

Fedyk, Nicholas. “Russian ‘New Generation’ Warfare: Theory, Practice, and Lessons for U.S. Strategists.” *Small Wars Journal* (25 August 2016): 1. Accessed 7 April 2017. http://smallwarsjournal.com/jrnl/art/russian-%E2%80%9Cnew-generation%E2%80%9D-warfare-theory-practice-and-lessons-for-us-strategists.

Fox, Amos, and Andrew Rossow. “Making Sense of Russian Hybrid Warfare: A Brief Assessment of the Russo-Ukrainian War.” *The Land Warfare Papers no. 112* (March 2017): 6-7.

Jacobson, Michael. “Why Cluster Munitions Must Be Replaced.” *War on the Rocks,* 2 September 2014. Accessed 6 April 2017. https://warontherocks.com/2014/09/why-cluster-munitions-must-be-replaced/.

Osborn, Kris. “US Army’s New Ground-Launched Missile: Raining Down Death from 500 Kilometers Away.” *The National Interest,* 6 September 2016. Accessed 30 March 2017. http://nationalinterest.org/blog/the-buzz/us-armys-new-ground-launched-missile-raining-down-death-500-17606.

Sengupta, Somini, and Andrew Kramer. “Dutch Inquiry Links Russia to 298 Deaths in Explosion of Jetliner Over Ukraine.” *New York Times,* 28 September 2016. Accessed 7 April 2017. https://www.nytimes.com/2016/09/29/world/asia/malaysia-air-flight-mh17-russia-ukraine-missile.html?_r=0.

Sewell, Justin. “U.S. Policy on Cluster Munitions and Its Susceptibility to Litigation.” *University of Washington Bothell Policy Journal* 13 (Fall 2009): 1-12. Accessed 4 April 2017. https://uwbpolicyjournal.files.wordpress.com/2012/01/u-s-policy-on-cluster-munitions.pdf.

Vergun, David. “Top 10 Army Modernization Efforts of 2016.” *Redleg Update* (March/April 2017): 9.

Online Sources

Center for Strategic and International Studies. “The Ukraine Crisis Timeline, The Battle in the Donbass Begins.” 23 May 2014. Accessed 1 May 2017. http://ukraine.csis.org/east1.htm.

_____. “The Ukraine Crisis Timeline, The Battle in the Donbass Continues.” 16 July 2014. Accessed 1 May 2017. http://ukraine.csis.org/east2.htm.

_____. “The Ukraine Crisis Timeline, Crisis in Kyiv.” 23 February 2014. Accessed 19 April 2017. http://ukraine.csis.org/kyiv.htm.

_____. “The Ukraine Crisis Timeline, Downing of MH17.” 4 September 2014. Accessed 1 May 2017. http://ukraine.csis.org/mh17.htm.

_____. “The Ukraine Crisis Timeline, Elections in Ukraine.” 10 February 2015. Accessed 1 May 2017. http://ukraine.csis.org/elections_ukr.htm.

_____. “The Ukraine Crisis Timeline, Minsk II to Present.” 1 February 2017. Accessed 3 May 2017. http://ukraine.csis.org/index.htm.

_____. “The Ukrainian Crisis Timeline, Annexation of Crimea.” 19 March 2014. Accessed 19 April 2017. http://ukraine.csis.org/crimea.htm.

Google Patents. “Patent US 3677182 A Base Ejecting Projectile.” Accessed 16 November 2016. https://www.google.com/patents/US3677182.

Hoffmann, Oliver. “Germany’s SMArt 155 Sensor-fused Artillery Ammunition Stops Tanks in their Tracks.” Rhinemetall Defense, 15 February 2010. Accessed 30 March 2017. https://www.rheinmetall-defence.com/en/rheinmetall_defence/public_relations/news/detail_1433.php.

Karber, Phillip, and Joshua Thibeault. “Russia’s New Generation Warfare.” Association of the United States Army, 20 May 2016. Accessed 26 May 2017. https://www.ausa.org/articles/russia%E2%80%99s-new-generation-warfare.

Keller, John, ed. “Raytheon to Help Army Develop New Long-Range Artillery Rocket for Battlefield Fire-Support.” Military and Aerospace Electronics, 16 March 2016. Accessed 30 March 2017. http://www.militaryaerospace.com/articles/2016/03/artillery-rocket-fire-support.html.

Lockheed Martin. “GMLRS Combat Proven - Always Ready to Fire.” 2011. Accessed 31 March 2017. http://www.lockheedmartin.com/content/dam/lockheed/data/mfc/pc/guided-unitary-mlrs-rocket/mfc-gu-mlrs-rocket-pc.pdf.

Lockheed Martin Media. “Lockheed Martin Receives $79 Million Contract for Production of Unitary Army Tactical Missiles.” 19 July 2005. Accessed 30 March 2017. http://news.lockheedmartin.com/2005-07-19-Lockheed-Martin-Receives-79-Million-Contract-for-Production-of-Unitary-Army-Tactical-Missiles.

O’Gorman, Rob. “Fire on Ice: Russia’s New Artic Brigades.” Offizere.ch, posted 22 June 2013. Accessed 7 May 2017. https://www.offiziere.ch/?p=12488.

Wikipedia. “BM 30 Smerch.” Wikipedia Foundation. Last modified 1 April 2017. Accessed 13 April 2017. https://en.wikipedia.org/wiki/BM-30_Smerch.

_____. “Budapest Memorandum on Security Assurances.” Wikipedia Foundation. Last modified 19 March 2017. Accessed 1 May 2017. https://en.wikipedia.org/wiki/Budapest_Memorandum_on_Security_Assurances.

_____. “Convention on Cluster Munitions.” Wikipedia Foundation. Last modified 21 February 2017. Accessed 24 February 2017. https://en.wikipedia.org/wiki/Convention_on_Cluster_Munitions.

_____. “Dual Purpose Improved Conventional Munition.” Wikipedia Foundation, 15 November 2016. Accessed 15 November 2016. https://en.wikipedia.org/wiki/Dual-Purpose_Improved_Conventional_Munition.

_____. “GUAM Organization for Democracy and Economic Development.” Wikipedia Foundation. Last modified 15 April 2017. Accessed 29 April 2017. https://en.wikipedia.org/wiki/GUAM_Organization_for_Democracy_and_Economic_Development.

_____. “M270 Multiple Launch Rocket System.” Wikipedia Foundation. Last modified 14 March 2017. Accessed 3 April 2017. https://en.wikipedia.org/wiki/M270_Multiple_Launch_Rocket_System#MLRS_rockets_and_missiles.

_____. “MGM-140 ATACMS.” Wikipedia Foundation. Last modified 31 March 2017. Accessed 3 April 2017. https://en.wikipedia.org/wiki/MGM-140_ATACMS.

_____. “Russian Military Intervention in Ukraine (2014–Present).” Wikipedia Foundation. Last modified 30 April 2017. Accessed 30 April 2017. https://en.wikipedia.org/wiki/Russian_military_intervention_in_Ukraine_(2014%E2%80%93present)#Background.

_____. “T-14 Armata.” Wikipedia Foundation, last modified 30 March 2017. Accessed 2 April 2017. https://en.wikipedia.org/wiki/T-14_Armata.

Briefings/Papers/Reports

Army Capabilities Integration Center. “Area Effects Gap Assessment with Loss of Artillery Cluster Munitions.” PowerPoint Presentation Fires Center of Excellence, Fort Sill, OK, 27 March 2016.

Cumming-Bruce, Nick, Katherine Harrison, Lucy Pinches, and Stuart Casey-Maslen. *Clearing Cluster Munition Remnants 2016.* A Report by Mine Action Review for the Sixth Meeting of State Parties to the Convention on Cluster Munitions. Oslo, Norway: Norwegian People’s Aid, 2016. Accessed 30 May 2017. https://mine.gov.hr/UserDocsImages//arhiva/files//Clearing_Cluster_Munition_Remnants_2016_WEB.pdf.

Doran, Peter. *Land Warfare in Europe, Lessons and Recommendations from the War in Ukraine*. Washington, DC: Center for European Policy Analysis, November 2016. Accessed 30 May 2017. https://cepa.ecms.pl/files/?id_plik=2991.

Dullum, Ove. “Cluster Weapons – Military Utility and Alternatives.” Norwegian Defence Research Establishment, Kjeller, Norway, 1 February 2008. Accessed 13 April 2017. http://www.ffi.no/no/Rapporter/07-02345.pdf.

Gordon, John, Anthony Atler, Scott Boston, Matthew E. Boyer, Natasha Lander, and Todd Nichols. *Comparing U.S. Army Systems with Foreign Counterparts: Identifying Possible Capability Gaps and Insights from Other Armies*. Santa Monica, CA: Rand Corporation, 2015. Accessed 25 April 2017. http://www.rand.org/content/dam/rand/pubs/research_reports/rr700/rr716/rand_rr716.pdf.

Human Rights Watch. “Survey of Cluster Munitions Produced and Stockpiled.” Briefing Paper Prepared for the ICRC Experts Meeting on Cluster Munitions. Montreux, Switzerland, April 2007. Accessed 22 May 2017. https://www.hrw.org/legacy/backgrounder/arms/cluster0407/.

Karber, Phillip, Ph.D. “‘Lessons Learned from the Russo-Ukrainian War: Personal Observations.” Historical Lessons Learned Workshop, Johns Hopkins Applied Physics Laboratory & U.S. Army Capabilities Center, Collaborative Analysis Center, Laurel, MD, 8 July 2015. Accessed 18 April 2017. https://prodev2go.files.wordpress.com/2015/10/rus-ukr-lessons-draft.pdf.

Thornton, Rod. “Military Modernization and the Russian Ground Forces.” Monograph, Strategic Studies Institute, U.S. Army War College, Carlisle Barracks, PA, 2011. Accessed 6 May 2017. https://ssi.armywarcollege.edu/pdffiles/PUB1071.pdf.