DO THE U.S. FIELD ARTILLERY'S CURRENT DOCTRINE, TRAINING, AND LEADERSHIP/EDUCATION DOMAINS ALLOW CANNON UNITS TO ESTABLISH AND MAINTAIN FIRING CAPABILITY IN A DEGRADED, DENIED, AND DISRUPTED SPACE OPERATING ENVIRONMENT?

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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After nearly two decades of the U.S. Military fighting in the Global War on Terror, the focus in training was for low-intensity conflict, counterinsurgency, and stability operations. Many U.S. Field Artillery units performed firebase operations with the focus on precision munitions and the digital systems associated with howitzers due to increased speed and accuracy. Many Field Artillery units performed non-standard mission sets leading to atrophy in core competencies and degraded operations. During the same two decades, peer adversaries like Russia and North Korea increased material and technological capabilities that create a degraded, disrupted, or denied space operating environment, which poses a severe threat to the digital systems that the U.S. Field Artillery has grown comfortable utilizing. This thesis seeks to answer, "Do the U.S. Field Artillery's current doctrine, training, and leadership/education domains allow cannon units to establish and maintain firing capability in a degraded, denied, and disrupted space operating environment?

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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

DO THE U.S. FIELD ARTILLERY'S CURRENT DOCTRINE, TRAINING, AND LEADERSHIP/EDUCATION DOMAINS ALLOW CANNON UNITS TO ESTABLISH AND MAINTAIN FIRING CAPABILITY IN A DEGRADED, DENIED, AND DISRUPTED SPACE OPERATING ENVIRONMENT?, by Major Robert T. Blackman, 127 pages.

After nearly two decades of the U.S. Military fighting in the Global War on Terror, the focus in training was for low-intensity conflict, counterinsurgency, and stability operations. Many U.S. Field Artillery units performed firebase operations with the focus on precision munitions and the digital systems associated with howitzers due to increased speed and accuracy. Many Field Artillery units performed non-standard mission sets leading to atrophy in core competencies and degraded operations. During the same two decades, peer adversaries like Russia and North Korea increased material and technological capabilities that create a degraded, disrupted, or denied space operating environment, which poses a severe threat to the digital systems that the U.S. Field Artillery has grown comfortable utilizing. This thesis seeks to answer, "Do the U.S. Field Artillery's current doctrine, training, and leadership/education domains allow cannon units to establish and maintain firing capability in a degraded, denied, and disrupted space operating environment?

ACKNOWLEDGMENTS

I decided to research this thesis due to happenstances in my career, coupled with observations as an OCT at the JRTC. I have spent my entire career on the M119A2, which is a non-digitally capable howitzer by the original design. I am more comfortable with performing degraded operations within the U.S. Field Artillery. Operations such as Astronomic Observation with the M2A2 Aiming Circle utilizing the Polaris and Kochab stars in the sky, Simultaneous Observation, and other hasty degraded artillery operations. It was not until I became an OCT at the JRTC where I saw the opposite with units. Units seem more comfortable using all the advanced digital systems and less comfortable with the degraded techniques that I was familiar with. I felt at a disadvantage and envied other units that were far superior at the digital systems than myself, but what I observed was once a digital system lost its function, many units struggled, and I was able to assist.

I want to thank my wife and daughters for allowing me to spend countless hours on the weekends and leave periods to work on my thesis. I want to thank my committee, Mr. Merrick, Mr. Williams, and LTC Nance for constant feedback and ultimately allowing me to fulfill the accomplishment of completing my thesis as well as their roles as my DJIMO, Tactics, and History instructors respectively throughout my time at the CGSC. I want to thank Mr. Tom Chychota also for his professionalism and candor while also assisting me with my thesis. Lastly, I want to thank the many NCOs whom I called upon to help lead me in the right direction while performing my research.

I appreciate all the support of everyone involved, and I hope my thesis meets or exceeds the expectations of everyone involved.

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ACRONYMS

5RAF	Five Requirements for Accurate Fire
ABCT	Armored Brigade Combat Team
AFATDS	Advanced Field Artillery Tactical Data System
ALC	Advanced Leader Course
ATN	Army Training Network
CATS	Combined Arms Training Strategy
CTC	Combat Training Center
D3SOE	Degraded, Denied, Disrupted Space Operating Environment
DFCS	Digital Fire Control System
DOTMLPF-P	Doctrine, Organization, Training, Material, Leadership/Education, Personnel, Facilities, Policy
DPRK	Democratic People's Republic of North Korea
FABOLC-B	Field Artillery Basic Officer Leader Course-Branch
FACCC	Field Artillery Captains Career Course
FADOWP	Field Artillery Degraded Operations White Paper
FCoE	Fires Center of Excellence
FCS	Fire Control System
FDC	Fire Direction Center
FDO	Fire Direction Officer
FSO	Fire Support Officer
FOC	Full Operational Capability
GPS	Global Positioning System
GFT	Graphic Firing Table

GLPS	Gun Laying Positioning System
GWOT	Global War on Terror
IBCT	Infantry Brigade Combat Team
IPADS-G	Improved Position and Azimuth Determining System-GPS
JRTC	Joint Readiness Training Center
LSCO	Large-Scale Combat Operations
METL	Mission Essential Task List
MLRS	Multiple Launch Rocket System
MOS	Military Occupation Specialty
MTOE	Modified Table of Organization and Equipment
OCT	Observer, Coach, Trainer
PNT	Positioning, Navigation, and Timing
POI	Program of Instruction
RTU	Rotational Training Unit
SBCT	Stryker Brigade Combat Team
SLC	Senior Leader Course
TFT	Tabular Firing Table
TTP	Tactics, Techniques, and Procedures
ULO	Unified Land Operations
USAFAS	United States Army Field Artillery School
WfF	Warfighting Function

TABLES

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CHAPTER 1

INTRODUCTION

The title of the thesis is, do the U.S. Field Artillery's current doctrine, training, and leadership/education domains allow cannon units to establish and maintain firing capability in a degraded, denied, and disrupted space operating environment?

The research topic examines Field Artillery Degraded Operations. The issues the researcher observes an over-reliance of U.S. Field Artillery Units on the digital aspects within the Field Artillery and a lack of analog skill sets required to establish and maintain firing capability in a Degraded, Denied, Disrupted Space Operating Environment (D3SOE). The problem is there is no generally accepted definition of Field Artillery Degraded Operations nor a standard proficiency level within the U.S. Field Artillery, Joint, or Army publications.[1] This thesis will attempt to assist the United States Army Field Artillery School (USAFAS) with the proposed definitions of degraded operations and degrees of degradation concerning digital and analog capacities. The research will analyze the doctrine, training, and leadership/education domains, and explore several Tactics, Techniques, and Procedures (TTP) for operations in a degraded, disrupted, denied environment. This thesis will attempt to establish how much training time a unit should dedicate to operating in a degraded environment versus training for full capability in a high-intensity conflict. This thesis relates to the academic field of Military Art and Science because the author will research the doctrine, training, and leadership/education

[1] United States Army Field Artillery School (USAFAS), *U.S. Army Field Artillery Degraded Operations White Paper 2.0* (Fort Sill, OK: Headquarters USAFAS, April 2017), 7.

domains in an attempt to solve issues that the U.S. Field Artillery will face in the future large-scale combat operations (LSCO).

The primary research question is, does current doctrine, training, and leadership/education support effective cannon unit operations in a D3SOE? This topic is significant to the military profession and other scholars because the United States' adversaries possess the capability to deny and degrade the U.S. Field Artillery's digital systems with systems such as the Russians via Unmanned Aerial Vehicles.[2] The Democratic People's Republic of North Korea (DPRK) can also jam Fire Finder Radar Systems, such as the U.S. Army AN/TPQ-37, as demonstrated in November of 2010 before an artillery barrage on Yeonpyeong Island.[3] The DPRK employs Electronic Warfare offensively and defensively as noted in a leaked 2005 publication stating, "If one disrupts the Global Positioning System (GPS) of U.S.'s precision-strike weapons, one can degrade its precision and lead it to strike another area."[4] The DPRK also has the means to jam GPS signals which current digital U.S. Field Artillery systems rely on for digital fire

[2] Lester W. Grau and Charles K. Bartles, "The Russian Reconnaissance Fire Complex Comes of age," University of Oxford Changing Character of War Centre, May 2018, accessed April 4, 2020, https://static1.squarespace.com/static/55faab67e4b0914105347194/t/5b17fd67562fa70b3ae0dd24/1528298869210/The+Russian+Reconnaissance+Fire+Complex+Comes+of+Age.pdf.

[3] Jenny Jun, Scott LaFoy, Ethan Sohn, "North Korea's Cyber Operations," Center for Strategic International Studies, December 2015, accessed April 4, 2020, https://csis-prod.s3.amazonaws.com/s3fs-public/legacy_files/files/publication/151216_Cha_NorthKoreasCyberOperations_Web.pdf.

[4] Ibid.

mission processing.[5] The DPRK is also credited for purchasing GPS jamming systems from the Russians with an effective range of 150 miles.[6] This fact speaks to the assumption that not only are the U.S.'s adversaries using the same equipment but are also colluding together to counter U.S. GPS reliant technology. By shifting the focus on more training to function in a degraded environment vice on the current focus of digital means will allow the U.S. Field Artillery to provide and maintain fires in support of Unified Land Operations (ULO) in the LSCO fight.

The answer to every problem for the military cannot be a more advanced or sophisticated material solution. For one, this process of material development can take decades, and our adversaries will adjust to countering the new material solution. The U.S. Field Artillery is now back in the same position of having adversaries with the ability to degrade updated digital systems. In the meantime, while such material breakthroughs are possibly developing, the U.S. Field Artillery community has several other viable answers to the problem. The U.S. Field Artillery community has techniques established that allow for providing accurate fires without the use of digital systems. An analog means of establishing and maintaining accurate fires is with the use of the M2A2 Aiming Circle. An M2A2 aiming circle is a tool much like surveyors use for determining azimuths for direction and elevation. It relies solely on the earth's magnetism and, therefore, adversaries cannot jam the M2A2 Aiming Circle. Fire direction is the tactical

[5] Bruce E. Bechtol, "Developments in the North Korean Asymmetric Threat: Missiles and Electronic Warfare," *International* Journal *of Korean Studies* 16, no. 2 (Fall 2012), accessed April 4, 2020. www.icks.org/data/ijks/1482460790_add_file_5.pdf.

[6] Ibid.

employment of firepower exercising the tactical command of one or more units in the selection of targets, concentration and distribution of fire, allocation of ammunition to each mission, and the methods and techniques used to convert target information into appropriate fire commands.[7] Fire Direction Centers (FDC) are the brains of the artillery and use a computer-based software system as the primary means for computing firing data. FDCs also can compute firing data through analog means with the use of Graphic Firing Tables (GFT), Tabular Firing Tables (TFTs), and chart plotting boards. These tools, like the M2A2 Aiming Circle, also deny adversaries of jamming or degrading.

During the Global War on Terror (GWOT), the risk of collateral damage increased, and the need for faster and more accurate fires increased; thus, the U.S. Field Artillery community saw an emphasis on digital and precision fires. Collateral Damage is a term for the inadvertent, although the unforeseeable killing of civilians in war.[8] It is estimated that between 10 to 13 percent of all deaths in Iraq are attributed to bombs and bullets from the U.S., thus adding to the necessity for precision digital fires.[9] Digital fires are unarguably faster and more accurate, but the U.S. Field Artillery cannot have expertise in only digital fire direction. During the GWOT, the military community saw minimal electronic warfare jamming from adversaries. During this same period, the

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[7] Headquarters, Department of the Army (HQDA), Training Circular (TC) 3-09.81, *Field Artillery Manual Cannon Gunnery* (Washington, DC: Government Publishing Office, April 2016), 1-2.

[8] Neta C. Crawford, "Civilian Death and Injury in the Iraq War, 2003-2013," Boston University, March 2013, accessed April 4, 2020, https://watson.brown.edu/costsofwar/files/cow/imce/papers/2013/Civilian%20Death%20and%20Injury%20in%20the%20Iraq%20War%2C%202003-2013.pdf.

[9] Ibid.

atrophy in analog means in fire direction, and fire delivery also grew exponentially. The future fight with peer adversaries such as Russia, North Korea, or China will not occur without the use of electronic warfare and jamming. The United States' adversaries possess the ability to affect digital and GPS systems.[10] This thesis is significant because the results could improve military practice, effectiveness, and employment of U.S. Field Artillery cannon units in LSCO. The findings potentially can fill the gap in the analog skills that atrophied during the GWOT and encourage the maintenance of firing capability in future LSCO.

The topic of artillery operations and firing capability in a degraded environment will attempt to fill a gap in the scholarly literature by exploring the domains of doctrine, training, and leadership/education. By researching the domains, the author will determine if units currently possess the doctrine, Mission Essential Task Lists (METL), and requisite leadership education to establish and maintain firing capability in a degraded environment.

The researcher is qualified to explore this topic because the researcher's career has been primarily with degraded functions and non-digital systems in the U.S. Field Artillery. The author is proficient in the TTPs on how to provide fires with analog means. The researcher spent two years as an Observer, Coach, and Trainer (OCT) at the Joint Readiness Training Center (JRTC). The JRTC is a Combat Training Center (CTC) located at Fort Polk, LA, with the primary focus of training Infantry Brigade Combat

[10] Joe Gould, "Electronic Warfare: What U.S. Army Can Learn from Ukraine," *Defense News*, August 2, 2015, accessed April 4, 2020, https://www.defensenews.com/home/2015/08/02/electronic-warfare-what-us-army-can-learn-from-ukraine/.

Teams (IBCT), focusing on a Decisive Action Training Event. The author spent the first year was as a Battalion Fires Cell OCT and the last year as the Senior Fires OCT at Live Fire Division. In the Live Fire Division, the researcher was responsible for all fires coordination, validation, and safe employment for indirect fires systems as well as fixed and rotary wing assets. During this time, the author saw a trend in the combination of a lack of skill and lack of will on Rotational Training Units (RTU) and their analog firing capabilities. Units were hesitant to perform an array of analog techniques like occupation without digital means, muzzle velocity inference, and muzzle velocity predictions without oversight from an OCT. These observations led the author to seek to address this topic.

Assumptions

Several assumptions are made in this thesis and will remain the same for the foreseeable future. The assumption that the U.S. adversaries can degrade, deny, or disrupt the U.S. Field Artillery digital systems and that the skill sets required to operate in this D3SOE remain a factor for Field Artillery Operations. Another assumption is that skill set proficiency in tasks that utilize analog equipment that does not require any electronic equipment receive the same attention in training by U.S. Field Artillery units as that of digital skillsets and functions.

Past Examples

The Fires Bulletin is a joint publication for U.S. Field Artillery professionals and acknowledges the same concerns as the researcher. Since around January 2017, the Fires Bulletin expresses and addresses the issue of U.S. Field Artillery units operating in a

D3SOE and interest over analog skill sets in almost all bulletins. Also, in 2017, a former student of the United States Army Command and General Staff College, Major Lucas Leinberger, wrote a thesis on how modern field artillery cannon battalions operate in a D3SOE and wrote on the five requirements for accurate fire (5RAF).

Defined below are several definitions and terms to better understand this thesis.

Doctrinal Terms and Definitions

The following definitions are essential to understand the research of this thesis.

Analog: The term analog, as defined by Army Doctrinal Publication (ADP) 6-0, is the manual processes and procedures that are void of automated systems.[11] For this thesis, the term analog refers to manual processes and procedures without the use of digital or automated equipment and tools.

Digital: The term digital for this thesis will mean the opposite of analog, as previously described. Digital includes any process or automated equipment that requires a computer, GPS device, or electronic item.

D3SOE: A denied, degraded, disrupted space operational environment is an environment where critical enablers such as satellite-communications, positioning, navigation and timing, and intelligence, surveillance, and reconnaissance assets have limited capabilities due to external threats.[12]

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[11] Headquarters, Department of the Army (HQDA), Army Doctrinal Publication (ADP) 6-0*, Mission Command* (Washington, DC: Government Publishing Office, July 2019), 4-15.

[12] Brigadier General Kurt Story, "Protecting Space in a Contested and Congested Domain," *Army Space Journal* (Winter/Spring 2010): 8.

Denied: Denied conditions, as defined by TC 3-09.8, are those situations where access to GPS, and digital communications via space capabilities is not available.[13]

Disrupted: Disrupted conditions occur when access to GPS and digital communications via space capabilities are intermittent and are not available consistently.[14]

Degraded: Degraded conditions occur when equipment or systems are working at reduced effectiveness, and alternative means must be utilized to maintain field artillery capabilities.[15]

Positioning, Navigation, and Timing (PNT): PNT refers to the data and information provided by GPS devices.[16] A way to create a Degraded, Denied, D3SOE is through the electronic warfare technique of jamming.

Jamming: Jamming is deliberate radiation, reradiation, or reflection of electromagnetic energy to prevent or reduce an enemy's effective use of the electromagnetic spectrum, and with the intent of degrading or neutralizing the enemy's combat capability.[17]

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[13] Headquarters, Department of the Army (HQDA), Training Circular (TC) 3-09.8, *Fire Support and Field Artillery Certification and Qualification* (Washington, DC: Government Publishing Office, February 2019), 1-9.

[14] Ibid.

[15] Ibid.

[16] Headquarters, Department of the Army (HQDA), Army Training Publication (ATP) 3-12.3, *Electronic Warfare Techniques* (Washington, DC: Government Publishing Office, July 2019), A-7.

[17] Ibid., 6-8.

Firing Capability: Firing capability, as defined by the researcher, is the ability to provide Field Artillery Fires at any given time.

GWOT hangover: The GWOT hangover is a term the author first heard while serving as an OCT at the JRTC. The underlying principles of the term are the habits that army units learned after almost two decades of fighting in Iraq and Afghanistan during a counter-insurgency fight. These habits, however, are crucial to the success in the GWOT fight are not necessarily applicable when conducting LSCO.

LSCO: LSCO is extensive joint combat operations in terms of scope and size of forces committed, conducted as a campaign aimed at achieving operational and strategic objectives.[18] An example of LSCO is that of World War Two or Operation Desert Storm, vice the GWOT in Iraq and Afghanistan. In Iraq and Afghanistan, we saw Brigade Combat Teams as the highest form of command and control, whereas in LSCO, we will tend to see Divisions or Corps and higher as the command and control elements.

ULO: ULO is the simultaneous execution of offense, defense, stability, and defense support of civil authorities across multiple domains to shape operational environments, prevent conflict, prevail in large-scale ground combat, and consolidate gains as part of unified action.[19]

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[18] Headquarters, Department of the Army (HQDA), Army Doctrine Publication (ADP) 3-0, *Operations* (Washington, DC: Government Publishing Office, July 2019), 1-5.

[19] Ibid., GL-9.

Training Terms and Definitions

The following training terms are essential for understanding the research of this thesis.

The Army Training Network (ATN): ATN is a website that allows military leaders to access training materials and guidelines to utilize for home station training. The training materials include the Combined Arms Training Strategy (CATS) and METL.

CATS and METL: CATS and METL are training guides that outline all required training tasks at the company and above levels for all army units regardless of a job set.

CTC: A CTC is a training location that observes, coaches, and trains units at the brigade level. Currently, the Army has three CTCs, the JRTC at Fort Polk, LA, the National Training Center at Fort Irwin, CA, and the Joint Multinational Readiness Center located in Germany.

RTU: RTU are the units that come to the CTCs for training are the RTU for that specific rotation, usually occurring monthly.

Educational/Leadership Terms and Definitions

The following educational and leadership terms are essential for understanding the research of this thesis.

Advanced Leader Course (ALC): The ALC is a school that focuses on leadership and technical skills required to prepare soldiers selected for promotion to staff sergeant to lead the squad and platoon-sized units effectively.[20]

[20] United States Army, "Lifestyles: Advanced Leader Course (ALC)," accessed December 27, 2019, https://www.goarmy.com/soldier-life/being-a-soldier/ongoing-training/leadership-training/advanced-leader-course.html.

Senior Leader Course (SLC): The SLC is a branch-specific course that provides an opportunity for soldiers selected for promotion to sergeant first class to acquire the leader, technical, and tactical skills, knowledge, and experience need to lead platoon and company size units.[21]

Army Career Management Fields (CMF): Army CMF, for simple terms, are all-encompassing jobs and personnel within a particular field in the army. For example, a soldier that fires a cannon, observers artillery fire, or performs on a Firefinder Artillery Radar System all belong to CMF 13. That said, all artillerymen belong to the CMF 13 and will have an additional identifier letter following the 13 designator.

Field Artillery Basic Officer Leader Course-Branch (FABOLC-B): The FABOLC-B is a school for new Field Artillery Lieutenants that learn the basics of fire support, fire direction, and Field Artillery Platoon Operations. The course is a pre-requisite before arriving at a new Lieutenants' first duty assignment upon active duty.

Field Artillery Captains Career Course (FACCC): The FACCC provides a challenging course of instruction to prepare students to think critically within ULO, possess the ability to provide adaptive and flexible leadership, conduct problem solving, conduct Field Artillery operations planning, synchronize fire support assets with maneuver, and demonstrate mastery of battery level operations.[22] The FACCC is the education provided to senior lieutenants and junior captains that enable them to serve as

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[21] United States Army, "Lifestyles: Senior Leader Course (SLC)," accessed December 27, 2019, https://www.goarmy.com/soldier-life/being-a-soldier/ongoing-training/leadership-training/senior-leader-course.html.

[22] Fort Sill Fires Center of Excellence, "FACCC Field Artillery Career Captain Course," accessed December 27, 2019, https://sill-www.army.mil/428thfa/faccc.html.

Battalion Fire Support and Fire Direction Officers (FDOs), Assistant Operations Officers, and Battery Commanders.

USAFAS: The USAFAS is headquartered at Fort Sill, Oklahoma trains, educates, and develops adaptive Marines, Soldiers, Officers, partner-nation leaders, and civilians to win in a complex world.[23] The USAFAS has fire support courses, simulation centers, live-fire ranges, classrooms, and facilities that provide realistic, tailor-made training solutions to U.S. and partner-nation units and leaders.[24] The USAFAS mission is to train soldiers, officers, and marines in TTPs for the use of fire support systems in combat.[25]

Other Terms and Definitions

The following terms are essential for understanding the research of this thesis.

Fire Support Officer (FSO): An FSO is the field artillery officer from the operational to tactical level responsible for advising the supported commander and assisting the senior fires officer of the organization on fires functions and fire support.[26]

FDC: The FDC is the element of the gunnery team with which the commander directs artillery firepower. The accuracy, flexibility, and speed in the execution of fire missions depend on multiple factors. Factors to include rapid and clear transmission of

[23] Fort Sill Fires Center of Excellence, "Fort Sill: USAFAS, Who We Are," accessed February 16, 2020, https://sill-www.army.mil/USAFAS/who-we-are.html.

[24] Ibid.

[25] Ibid.

[26] Headquarters, Department of the Army (HQDA), Field Manual (FM) 3-09, *Field Artillery Operations and Fire Support* (Washington, DC: Government Publishing Office, April 2014), 2-11.

calls for fire and fire commands, timely and accurate computations, integration of automated and manual equipment into an efficient, mutually supporting system, and efficient use of communications equipment.[27]

FDO: An FDO is responsible for all FDC operations. The FDO is responsible for the training of all FDC personnel, supervises the process of the FDC, establishes standard operating procedures (SOP), checks target location, announces fire order, and ensures the accuracy of firing data transmitted to the howitzers.[28]

Modified Table of Organization and Equipment (MTOE): The MTOE is a document that outlines all personnel by job set, rank, and quantity and also any equipment by type a specific unit requires to have on-hand.

Limitations

Limitations in this thesis include a six-month research timeline and a three-month thesis writing timeline. This thesis will utilize doctrine from the army publishing directorate and draft doctrine available from Fort Sill, articles and research material from the United States Combined Arms Research Library at Fort Leavenworth, the United States Field Artillery Schools programs of instruction and syllabi, The ATN, and CTC trends and analysis for data.

This thesis is the author's first experience in conducting original research. Evidence of the author's biases is confirmed in his pro-analog and semipro-digital outlook on providing fires. The author's career in digital systems for the U.S. Field

[27] HQDA, TC 3-09.81, 2-2.

[28] Ibid., 2-1.

Artillery is lacking, especially with digital methods for howitzers. The author learned manual gunnery in FABOLC and FACCC and served as a FDO, where training and employment on the archaic charts-and-darts techniques occurred regularly. The author never utilized a howitzer with digital systems as a FDO, platoon leader, nor battery commander. The only howitzer the author served on was an M119A2 105mm Howitzer. The first time the author saw a digital howitzer was during his second year as an Observer, Coach, Trainer (OCT) in the JRTC at Live Fire Division. Experiencing the mix of U.S. Field Artillery cannon platforms with and without digital systems is where the author's idea for this thesis originated. The author saw RTU struggle with providing fires when a digital system became non-mission capable.

This study will assess the feasibility and suitability of the model for this specific use in training plans and doctrinal references that identify the firing unit's ability to maintain firing capability in a D3SOE. This study will not include a detailed analysis of the Training Circular (TC) 3-09.81, Field Artillery Manual Cannon Gunnery due to the publication is in manual and analog TTPs for providing fire direction without the aid of digital systems. This study will, however, include a summary of TC 3-09.81 in the analysis chapter.

This study will not research any material solutions or technological developments to bypass the increasing advancements in the United States' adversaries jamming capabilities. This thesis will not contribute to any research and development theories or technologies. Still, it will strive to answer whether or not current domains of doctrine, organization, training, and leadership/education for the U.S. Field Artillery allow for establishing and maintaining firing capability should digital equipment become denied,

disrupted, or degraded. This study will not research the 13F Military Occupation Specialty (MOS) Programs of Instruction (POI) for the ALC and SLC.

This thesis will analyze the doctrine, training, and leadership/educational domains in an attempt to discover how ready U.S. Field Artillery cannon units can establish and maintain firing capability in a D3SOE. The research will review current and draft doctrine to find out what the references direct and guide units to utilize for establishing and maintaining firing capability in a degraded environment. Analyzing the METL and collective U.S. Field Artillery tables will provide an accurate picture of what required degraded training units are currently conducting for future LSCO. By scrutinizing the USAFAS Non-Commissioned Officer (NCO) and Officer POIs for ALC and SLC for various Career Management Field (CMF) 13 series MOS and Field Artillery Officers, the author will establish an institutional baseline knowledge of what U.S. Field Artillery NCOs and Officers possess upon graduating their education course by rank. One exception regarding the POIs is that the research will not include the Multiple Launch Rocket System (MLRS) portions for the 13J MOS as this thesis is focusing strictly on U.S. Field Artillery Cannon Battalions. Last, this thesis will use personal observations from the researcher to summarize data, trends, and After-Action-Reviews (AAR) from the CTC to offer real-world outlook of the applications described above. This thesis will do an extensive literature review of doctrine, case studies, MTOEs, and institutional programs of instructions to help facilitate this knowledge implementation.

CHAPTER 2

LITERATURE REVIEW

The purpose of this thesis is to examine the question: Does current doctrine, education, and collective artillery training tables support effective cannon unit operations in a D3SOE. The literature review is comprised of an analysis of the Fires Journal from 2015 to present, the USAFAS Field Artillery Degraded Operations White Paper, and a prior Master of Military Art and Science thesis on field artillery operations in a D3SOE.

Field Artillery Fires Journal

The Fires Journal is a joint publication for U.S. Artillery Professional published six times a year, where each edition captures two months of articles. For example, there is a January-February publication, a March-April publication, a May-June publication, a July-August publication, a September-October publication, and a November-December publication. While reviewing the literature from the Fires Journals from 2015 to present, there is a shift in focus from that of maintaining core artillery competencies to that of operating in a D3SOE.

In the September-October 2015 edition of the Fires Journal, there are two articles addressing issues with competency levels of Field Artillery Organizations, including fire support, fire direction, and fire delivery operations. CPT Lucas Leinberger, now MAJ Leinberger, who will later be referenced for his thesis in 2017, wrote an article on how years of continuous deployments and non-standard missions for the artillery community

in the GWOT contributed to degradation in Field Artillery training and planning.[29] In the same edition, OCTs from the JRTC shed perspective on Fire Support Planning during a Decisive Action Training Event. The OCTs states that their experiences overly influence maneuver commanders at the company and battalion level during the counter-insurgency fights in the GWOT.[30] The results of said habits resulted in limited integration of fires in support of maneuver operations at the JRTC, as observed by the OCTs.[31] While not a specific correlation to U.S. Field Artillery units operating in a D3SOE, both articles elude to the same observations of the researcher.

In contrast, a constant presence in the GWOT reduced competencies and skill sets of U.S. Artillery units. Colonel Stephen Maranian, now Major General Maranian, applied the same emphasis of artillerymen becoming experts in standards and core competencies across all field artillery skills when he first became the Commandant of the USAFAS in 2016.[32] In the July-August 2016 Fires Journal, there is an article on the interoperability of fire support systems and product dissemination while conducting multi-national operations. The authors of that article discuss the inherent friction of fire support planning and execution and the compounding effects while performing multi-national

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[29] Captain Lucas Leinberger, "Restoring and Preserving Field Artillery Competencies," *Fires Journal* (September/October 2015): 34.

[30] Major Glenn Neilson, Captain Brett Maginness, and Sergeant First Class Gregory Artise, "Reuniting the King and Queen of Battle," *Fires Journal* (September/October 2015): 39.

[31] Ibid.

[32] Colonel Stephen Maranian, "The United States Field Artillery Vision," *Fires Journal* (November/December 2016): 9.

operations. Several sustaining factors in the report include the nesting of analog systems in North Atlantic Treaty Organization doctrine, and distilling said systems to understandable analog graphics.[33] The article explains that regardless of nationality or language, an analog map and fire support overlay ensure shared understanding and coordinated and effective fires.[34] The report does acknowledge that while analog systems provide a common language and efficiency, to provide speed and accuracy, the use of interoperable digital systems is necessary.[35] While the researcher will never argue the speed and accuracy of digital methods within the U.S. Field Artillery, the utilization of analog systems serves as a starting point for providing firing capability. In the event of a digital system losing functionality, analog systems allow for the maintenance of firing ability.

According to Major Fred Janoe in the November-December 2016 edition of the Fires journal, U.S. Field Artillery Battalions rely heavily on upper tactical internet to generate products and to maintain the common operational picture.[36] In doing so, transferring Fire Support Coordination Measures are seldom transferred to analog trackers, which becomes a problem when digital connectivity is lost.[37] MAJ Janoe, in his

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[33] Lieutenant Colonel Deric Holbrook, Captain Andrew Cotter, and Captain Jerry Hodge, "Greater than the sum of our parts," *Fires Journal* (July/August 2016): 44.

[34] Ibid.

[35] Ibid.

[36] Major Fred Janoe, "Executing effective decisive action Fires based on observations at the National Training Center," *Fires Journal* (November/December 2016): 54.

[37] Ibid.

recommendations, offers the idea that for fire support systems to operate efficiently, the vitality of leaders ensuring everyone understands their roles, and capabilities and limitations of equipment is paramount.[38] While MAJ Janoe does not clearly state the importance of maintaining both analog and digital skills, the researcher infers that the METL tasks MAJ Janoe recommend supporting the same recommendations and trends as the researcher. Functions that enable proficiency, such as synchronizing fire support operations, conducting fire support, and synchronizing fires, can accomplish his intended statement of maintaining both digital and analog systems for providing fires.

The May-June 2017 edition of the Fires Journal is where the shift in focus of degraded artillery operations in the future fight begins to take root. In the article Future Army cross-domain fires, the acknowledgment that potential adversaries threatening the Army in all domains exists and that degraded operations are a likelihood for the future battlefield.[39] The article discusses how the U.S. adversaries, specifically Russia and China, invest in technologies like long-range precision fires, air defense systems, and unmanned aircraft systems, all with the intent of denying the U.S. ability to achieve overmatch.[40] The article further discusses how the Army faces serious competition in cyberspace and the electromagnetic spectrum at tactical levels where friendly capabilities are severely immature compared to the U.S. peer competitors.[41] In the same journal

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[38] Janoe, 54.

[39] James Howard, "Future Army cross domain Fires," *Fires Journal* (May/June 2017): 26.

[40] Ibid., 25.

[41] Ibid.

publication, but in a different article addressing imperatives in multi-domain operations, William Dries discusses how during the GWOT, the U.S. knew radios and computer networks were unsusceptible to jamming or disruption, lulling the U.S. Army into a false sense of security after almost two decades of the GWOT.[42] The continuing conflict in the Middle East in an uncontested operational environment is where the U.S. has seen the majority of combat operations that have led to the bad habits and nature of warfare addressed in this thesis. The article continues to address the same issues of how Russia and China are deliberately seeking and presenting asymmetrical challenges to the U.S. that contest U.S. dominance in each domain.[43] Any disruption, even a temporary interruption, might be all that the U.S. adversaries need to seize the initiative in a future conflict.[44]

In the November-December 2017 issue of the Fires Journal, Captain Michael Wish wrote an article titled, Countering future threats by maintaining manual gunnery proficiency. The article discusses again how artillerymen and years of constant rotations to the Middle East performing non-traditional missions has led to atrophy in core artillery skills. The report also acknowledges that recent events with Russian adversaries suggest that the most significant emerging threat is the use of electronic warfare. Captain Wish suggests the same issues as the researcher, how removing analog training and techniques at the schoolhouse eludes to a far more significant problem in the artillery community. In

[42] Colonel William Dries, "Some new, some old, all necessary: The multi-domain imperative," *Fires Journal* (May/June 2017): 16.

[43] Ibid., 17.

[44] Ibid.

efforts to modernize the Field Artillery branch, digital dependency is evident and has led to far more significant issues. The over-reliance on digital addiction poses extreme vulnerabilities in U.S. Artillery units is echoed throughout the article. The article also provides supporting evidence on trends from the JRTC and how U.S. Artillery units struggle with maintaining firing capability should digital systems degrade and also how the USAFAS POIs allow for minimal degraded FDC training. Captain Wish addresses many of the same issues as this thesis regarding over-reliance on digital systems, lack of proficiency on analog techniques, and all supported by CTC trends and data collection.

In the May-June 2018 edition of the Fires Journal article, The Fires Complex: Organizing to win in LSCO, Colonel Chris Compton and Lewis Boothe reiterate the facts of operating in contested environments will shape future conflicts. The article discusses how working in Multi-Domain Operations will require a revolutionary shift in current fires capability and employment.[45] While the main points of the report focus on force structure, modernization, and abilities, the idea of U.S. Field Artillery units having to perform in a contested environment remain and thus further elude to the growing challenges to overcome

In the November-December 2018 edition of the Fires Journal article, If Henry Knox were alive today: A discussion on future artillery warfighting, Major Jeremy Blascak echoes similarities of digital reliance in the U.S. Field Artillery and the impacts for future conflicts. Maj Blascak identifies that trends at the JRTC demonstrate habitual

[45] Colonel Chris Compton and Lewis Lance Boothe, "The Fires complex: Organizing to win in large-scale combat operations," *Fires Journal* (May/June 2018): 4.

patterns of units failing to plan or train for degraded operations.[46] He states that the same over-reliance on digital systems coupled with the atrophy of analog artillery skills poses significant vulnerabilities in future contested environments against competitors with similar or even higher capabilities as the U.S.[47] Major Blascak acknowledges the added benefit of speed and reduced human effort with digital systems when functioning correctly. However, the ability to provide fire support in a degraded environment has atrophied due to continuous rotations during the GWOT and training scenarios.[48] He addresses that the 2014 Ukrainian conflict highlights the capabilities for potential adversaries to utilize electronic warfare to jam GPS signals, disrupt artillery electronic fuzes, and target signals that artillery units present as an electronic signature.[49] The article further discusses the exposed weaknesses of an over-reliance on digital systems, albeit digital systems achieve increased speed and accuracy, the ability to provide fires without the use of computer-aided devices, and GPS to process fire missions are inevitable for future conflict. Major Blascak uses the analogy of how soldiers train land navigation first with a map and compass before using a digital tracking system to aid in navigation and that the same methodology in artillery core competencies is vital. He states that soldiers must continue to train degraded methods of processing fire missions, laying howitzer positions, and utilize techniques to ensure firing capability without the

[46] Major Jeremy Blascak, "If Henry Knox were alive today: A discussion on future artillery warfighting," *Fires Journal* (November/December 2018): 62.

[47] Ibid.

[48] Ibid.

[49] Ibid.

aid of digital systems.[50] To further highlight the lack of proficiency in degraded artillery, Major Blascak references that all 2016 live-fire incidents that occurred had a direct attribution to the firing unit operating in a degraded status.[51] Due to the increasing likelihood of fighting in a contested environment where potential adversaries can impact digital operations and the electromagnetic spectrum, artillery units must place the same energy in training both the analog and digital processes.[52] U.S. Field Artillery units cannot master only one spectrum of the operational environment. They must place equal emphasis on operating in both a non-contested as well as a contested operational environment. Major Blascak's article acknowledges the speed and precision that digital systems provide, however highlighting the vulnerabilities of an over-reliance on the same digital systems. He emphasizes the importance of equal mastery of both establishing and maintaining firing capability by digital and analog means.

Approximately 18 months after the identification of the possibility of operating in a contested environment, the January-February 2019 edition of the Fires Journal has an article from the USAFAS commandant, Brigadier General Stephen Smith. In the article, Field Artillery: Looking Forward to 2019, the shift in priorities within the field artillery is evident. Brigadier General Smith lays out the way ahead for 2019 with regards to preparation for LSCO. The second bullet acknowledges that the USAFAS will increase the amount of degraded operations instruction in all courses. Some courses include a

[50] Blascak, 63.

[51] Ibid.

[52] Ibid.

degraded call for fire, manual gunnery, aiming circle training, and a multitude of other courses. The shift in prioritization is a crucial step in the right direction for the field artillery branch. The fact that the acknowledgment is coming from the USAFAS commandant, Brigadier General Smith, is demonstrative of the efforts on focusing the branch in the right direction regarding contested environments in LSCO.

In the May-June edition of the Fires Journal, Captain Neal MacDonald wrote an article titled Preparing for artillery operations in a GPS denied environment. He gives a background on PNT capabilities and the relevance to the field artillery, the emerging threat for potential U.S. adversaries, planning factors for operating in a denied environment, and techniques with associated doctrinal references. Captain MacDonald breaks down impacts in a GPS denied environment by Warfighting Function (WfF). For fires, he addresses that the loss of precision-guided munitions capabilities and that artillery piece positioning and laying by degraded and manual techniques are the impacts in a GPS denied scenario.[53] Captain MacDonald states that the most critical element in dealing with GPS interference is preparation and that through education, doctrine, and training on GPS denied environments is imperative.[54] He mentions that the opportunities exist starting at advanced individual training through CTC rotations and that creating environments where soldiers can directly observe GPS interference effects regarding equipment and operations.[55] Captain MacDonald focuses on the fact that U.S. Field

[53] Captain Neal MacDonald, "Preparing for artillery operations in a GPS denied environment," *Fires Journal* (May/June 2019): 36.

[54] Ibid.

[55] Ibid.

Artillery units' primary means for operations is that of digital systems, the soldier's ability to identify when under GPS interference, and thus referring to analog means to establish and maintain firing capability is paramount.

After reviewing the past five years of the Fires Journal, the acknowledgment of operating in a contested environment emerged around mid-2017. While mentions of U.S. Field Artillery units maintaining core competencies in the Fires Journal occur before mid-2017, it is at this point where the Fires Journal starts showing trends of near-peer adversarial capabilities. Russia and China are the emerging threats mentioned and the roles of the contested environments they can impose on the U.S. Field Artillery organizations. Multiple authors state the importance of U.S. Field Artillery units requiring the ability to establish and maintain firing capability in a contested environment. The same authors also highlight that the revolving door effect of deploying in support of the GWOT has further degraded the competencies of the field artillery. The issue is due to many artillerymen performing non-traditional combat missions or the simple fact of the middle east being a non-contested and static environment for artillerymen. The authors reference CTC trends and real-world case studies as lenses to view the epidemic of an over-reliance on digital systems and the vulnerabilities that can ensue. The fires community, as addressed through the Fires Journal, is aware of the problem set before the field artillery branch and is working on updating doctrine, training plans, and educational courses to efficiently and effectively rectify the current state of the field artillery branch.

The Field Artillery Degraded Operations White Paper

The most significant source is the USAFAS Field Artillery Degraded Operations White Paper 2.0 (FADOWP 2.0). There is a connection between the FADOWP 2.0 and the articles published from the Fires Journal during the same time regarding operating within a D3SOE. In April of 2017, the USAFAS published the white paper to ensure that U.S. Field Artillery units incorporate operations and training in degraded conditions. The FADOWP 2.0 highlights that even though more sophisticated and advanced techniques for fires integration and delivery on the battlefield is essential, unit awareness that digital system denial or failure is inevitable. The FADOWP 2.0 drives the mindset of U.S. Field Artillery units must provide effective fires under all conditions and ensuring unit training plan accounts for such situations. The FADOWP 2.0 offers a general understanding of the operating environment and acknowledges that U.S. Adversaries are developing the capability to mass effects from multiple domains at a speed that will impact ongoing operations.[56] It also addresses how the U.S. Military is increasing its reliance on space-based assets such as satellites, PNT, and intelligence, surveillance, and reconnaissance.[57] The FADOWP 2.0 acknowledges that adversaries will use electronic warfare technology, and the U.S. Field Artillery units should prepare, plan, and train to transition to overall establish and maintain firing capability in a contested operating environment. The construct of the FADOWP 2.0 outlines capabilities with the 5RAF.

[56] USAFAS, *U.S. Army Field Artillery Degraded Operations: White Paper 2.0*, 6.

[57] Ibid.

Accurate target location is critical for achieving first-round effects on targets, and the use of position locating systems, mensuration tools, and laser rangefinders are essential as addressed by the FADOWP 2.0. The FADOWP 2.0 provides fire supporters a means to consistently determine accurate target location in degraded operations for various mounted and dismounted systems. Mounted systems include the M3A3 Bradley with Fire Support Surveillance Sensor and the armored knight. Dismounted methods include the lightweight laser designator rangefinder, pocket-sized forward entry device, and laser target locator modules. For the mounted systems, the FADOWP 2.0 provides fire supporters the data that the vehicles are equipped with GPS enabled inertial navigation units (INU) that allow for accurate positions and direction information even after movements over large amounts of terrain.[58] The FADOWP 2.0 addresses capabilities and techniques for providing fire supporters the ability to provide accurate target location and size in a contested environment for digital fire support systems on the MTOE.

Accurate firing unit location is determined by the components of position, direction, and location.[59] The FADOWP 2.0 addresses the various systems U.S. Field Artillery units utilize for providing precise firing unit location and techniques in a degraded environment. Systems the FADOWP 2.0 addresses are the Improved Position and Azimuth Determining System-GPS (IPADS-G), individual howitzer INUs, the M67 Gun Laying Positioning System (GLPS), and the M2A2 Aiming Circle. The FADOWP

[58] USAFAS, *U.S. Army Field Artillery Degraded Operations: White Paper 2.0*, 14.

[59] Ibid., 19.

2.0 does address that if the aiming circle is not operational, the use of an appropriately declinated M2 compass is necessary until the aiming circles are functional.[60] For U.S. Field Artillery units to provide accurate firing unit location, the FADOWP 2.0 addresses both digital and analog systems functionality characteristics and techniques needed should a degraded operating environment occur.

Firing units, FDCs, and sustainment cells develop and provide accurate weapon information.[61] Weapon information includes weight, fuze type, muzzle velocity variations, and propellant temperatures. The FADOWP 2.0 addresses that degraded conditions do not typically affect weapon information except for precision munitions. The FADOWP 2.0 acknowledges that a GPS denied environment affects the full capability of precision munitions and that units should use other munitions.[62]

Accurate meteorological information includes atmospheric conditions such as wind, air temperature, and air density along the trajectory of a projectile.[63] The FADOWP 2.0 provides information on the AN/GMK-2 Computer Meteorological Data-Profiler and the effects caused during degraded conditions. The FADOWP 2.0 identifies that in degraded conditions, the meteorological data is sent over any available

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[60] USAFAS, *U.S. Army Field Artillery Degraded Operations: White Paper 2.0*, 19.

[61] Ibid., 26.

[62] Ibid.

[63] Ibid.

communications method and worst-case scenario; units must register to account for such situations.[64]

Accurate computational procedures affect all systems, either digital or analog, due to the human error factor involved. The Advanced Field Artillery Tactical Data System (AFATDS) is a digitized and integrated battlefield management and decision support system that functions from firing platoon through Echelons above Corps.[65] The FADOWP 2.0 addresses that under degraded conditions, the AFATDS is capable of continuing to provide accurate computational firing data even when no connection to the network exists or GPS is not available, however, it relies solely on the operator to input correct data.[66] The AN/PYG-1A Centaur is a handheld technical fire direction system that serves as a backup to the AFATDS or as the initial occupation system for automated technical fire direction solutions.[67] The centaur, much like the AFATDS during degraded conditions, is capable of continuing to provide accurate computational firing data even when no connection to the network exists or GPS is not available but relies on the operator to input correct data as addressed in the FADOWP 2.0.

Regarding manual computational procedures, TC 3-09.81, Field Artillery Manual Cannon Gunnery states that manual back is established during position improvement and

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[64] USAFAS, *U.S. Army Field Artillery Degraded Operations: White Paper 2.0*, 28.

[65] Ibid., 29.

[66] Ibid.

[67] Ibid.

should not impede set up or processing with automated means.[68] The FADOWP 2.0 provides fire supporters with conditions, TTPs, and mitigation for providing accurate computation procedures in a degraded environment. In large, inaccurate computational procedures are not necessarily a factor from degraded conditions but more so in that of human error.

The FADOWP 2.0 summarizes in providing readers with recommended time standards, recommended priority of mode of operations for automated howitzers, recommended survey control point establishment, and common terms and definitions seen throughout the white paper. There are several annexes included in the FADOWP 2.0, which include manual FDC kits items and recommended forward observer equipment. The most significant annexes are the final three. Annex C is a Graphic Training Aid (GTA) that outlines electromagnetic interference mitigation TTPs for GPS enabled devices. Annex D is a GTA that describes electromagnetic interference mitigation TTPs for Satellite Communications. Annex E is a graphic representation of space-linked equipment common in a brigade combat team for users to reference all equipment, which poses a vulnerability during a contested environment. The final Annex, Annex F, is a Degraded Operations Doctrine, Organization, Training, Material, Leadership/Education, Personnel, Facilities, Policy (DOTMLPF-P) mitigations and impact quick reference sheet which references the 5RAF plus radar and clearance of fires. Aligned with the needs are effects, DOTMLPF-P mitigators, and impacts on the said requirement in a degraded environment.

[68] HQDA, TC 3-09.81, Sect. E-12.

The FADOWP 2.0 provides fire support personnel with a quick reference document for addressing possible issues in a degraded environment and their relation to the 5RAF. The FADOWP 2.0 equips fire supporters with possible ways of utilizing digital systems in a degraded environment to establish still and maintain accurate firing capability. It also provides annexes of manual equipment and national stock numbers associated with units to order against the supply system. Finally, the annexes provided within the FADOWP 2.0 prepare readers with a reference on operating GPS enabled equipment and satellite communications platforms and their vulnerabilities and indicators when electromagnetic interference is present.

How does a modern field artillery cannon battalion operate in a D3SOE?
MMAS Thesis by MAJ Lucas Leinberger

The most significant writer that the researcher has found on this subject is that of MAJ Leinberger, with an MMAS topic in 2017, "How does a modern field artillery cannon battalion operate in a degraded, denied, and disrupted space operating environment?" His thesis analyzed the characteristics of the 5RAF against the FADOWP, CTC AARs, and the Russian-Ukrainian War. In contrast, the researcher will focus on the doctrine, training, and leadership/education domains to analyze this topic. His overall analysis concluded that the limiting factor for achieving the 5RAF comes down to FM communications.

MAJ Leinberger's analysis of the FADOWP concluded that the Fires Center of Excellence (FCoE) attempted to address degraded operations and identified the fundamental skills necessary for U.S Field Artillery cannon battalions to operate in a

degraded capacity successfully.[69] He also highlights that the FADOWP lacks recommendations or solutions to overcome operations specific to a D3SOE, for example, the denial of communications rather simple degradation.[70] MAJ Leinberger mentions that the FADOWP recommends TTPs like using wires to establish radio communications, the FADOWP fails to acknowledge the absence of radio wires on U.S. Field Artillery unit MTOEs.[71] Another negative critique by MAJ Leinberger is that the FADOWP includes recommendations for manual computations. The issue again is that it is dependent still on U.S. Field Artillery unit MTOEs and property books for items such as indirect fire plotting boards, and artillery fire control plotting sets.[72]

MAJ Leinberger also provides a thorough analysis of CTC AARs, home station AARs, and firing incident reports using the 5RAF as the criteria for review. His study concluded that units have an overall moderate level of success in achieving some of the 5RAF, and the areas of struggle include accurate meteorological information and accurate computational procedures in a D3SOE.[73] He identifies a significant trend among units regarding maintaining communication system proficiency in normal operating conditions. One example MAJ Leinberger mentions is how a disruption in communications led to a

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[69] Major Lucas Leinberger, USA "How does a modern Field Artillery Cannon Battalion operate in a Degraded, Denied, and Disrupted Space Operating Environment?" (Master's Thesis, U.S. Army Command and General Staff College, Fort Leavenworth, KS, 2017), 53.

[70] Ibid.

[71] Ibid.

[72] Ibid.

[73] Ibid., 63.

unit having issues in computational procedures resulting in a duplicate fire mission that led to a "Check Firing" status until completion of an investigation.[74] MAJ Leinberger's assumption in the matter is a lack of digital sustainment training proficiency.

MAJ Leinberger's thesis also analyzes reports on the Russo-Ukrainian War and the effects on the 5RAF. He concluded that the areas of most significant concern are the ability to achieve accurate target location and size, accurate weapon and ammunition information and accurate meteorological information.[75] These requirements were affected the most due to the limitations of communication systems and positioning devices.[76] He concludes that the Field Artillery Battalion operating in the Russo-Ukrainian War did not adequately meet all of the 5RAF.[77]

The basis for MAJ Leinberger's overall findings is on a research methodology that facilitates conclusions and recommendations for capabilities development, all based on the 5RAF. He found that all 5RAF are dependent on FM communications.[78] He mentions that even though observers have the means to determine accurate target location and size using manual procedures, no doctrine covers how to transmit to the FDC when

[74] Leinberger, 64.

[75] Ibid., 75.

[76] Ibid.

[77] Ibid.

[78] Ibid., 76.

FM communications are degraded, denied, or disrupted. MAJ Leinberger determines that this is a potential material shortfall in the U.S. Army.[79]

MAJ Leinberger's second finding deals with accurate firing unit location.[80] He mentioned the same aspects as the researcher with regards to how the FADOWP provides an effective means of acquiring survey data using the IPADS-G. The shortfall of the FADOWP is that there is no mention of any means to allow transmission of unit location or survey data when operating in denied FM communications conditions.[81] MAJ Leinberger notes that CTC AARs demonstrates that U.S. Field Artillery units' ability to effectively acquire accurate unit location using GPS or manual survey techniques are lacking. However, communication systems failures in training degrade the ability for units to receive common survey.[82]

MAJ Leinberger's third finding highlights accurate weapon and ammunition information. He concludes that units ultimately faced difficulty transmitting the data when communications became degraded or failed altogether.[83] His analysis determines that the doctrinal, training, and material gaps are also incumbent with identifying accurate weapon and ammunition information.

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[79] Leinberger, 77.

[80] Ibid.

[81] Ibid.

[82] Ibid.

[83] Ibid., 78.

MAJ Leinberger's fourth finding regarding Accurate meteorological information is dependent upon digital connectivity from a Global Broadcast System (GBS) and FM Communications.[84] The requirement for accurate meteorological information in MAJ Leinberger's thesis demonstrates that doctrine fails to provide a means to overcome communication shortfalls to acquire meteorological information in a D3SOE.[85] MAJ Leinberger highlights that in the Russo-Ukrainian War, the trend in jamming posed a severe threat as well as Russian electromagnetic targeting capabilities.[86]

MAJ Leinberger's fifth finding regarding accurate computational procedures is also dependent on FM communications. His analysis highlights an over-reliance on Field Service Representatives to overcome problems with systems such as the AFATDS and connectivity between multiple systems.[87] MAJ Leinberger reiterates the material gap that in the absence of digital systems like the AFATDS, FDCs require analog equipment to compute fire missions and that required equipment is absent from MTOEs.

MAJ Leinberger's overall conclusion in the analysis is the trend of communications and PNT system challenges continued.[88] His report culminated with five

[84] Leinberger, 79.

[85] Ibid.

[86] Ibid.

[87] Ibid.

[88] Ibid., 81.

findings, all relating to one of the 5RAF and how said results help describe what a U.S. Field Artillery Battalion needs to succeed in a D3SOE.[89]

Summary

The review of the literature for this thesis focused on three principal sources. The first source was a review of the fires journal dating back five years, from 2015 to 2020. The trend in the fires journal was that at first, Field Artillerymen strived to focus the branch into a sort of re-bluing on core competencies from over a decade of fighting the GWOT and to cure the GWOT hangover. Around 2017, the fires community started focusing not only on a re-bluing of core competencies but with an added focus of operating in a degraded environment. As the years progressed, readers of the fires journal started to appreciate why the focus was changing. That shift in focus is due to the threat of our peer adversaries pose, such as Russia and China.

The second source of literature for review for this thesis was FADOWP 2.0. The FADOWP provides fire support personnel with a document for addressing possible issues in a degraded environment and their relation to the 5RAF. The FADOWP equips fire supporters with probable ways of utilizing digital systems in a degraded environment to establish and maintain firing capability. Last, the annexes provided within the FADOWP 2.0 prepare readers with a reference on operating GPS enabled equipment and satellite communications platforms and their vulnerabilities and indicators when electromagnetic interference is present.

[89] Leinberger, 81.

The third most significant source for this thesis was the MMAS by MAJ Lucas Leinberger in 2017 titled, “How does a modern Field Artillery Cannon Battalion operate in a D3SOE?” MAJ Leinberger analyzes the FADOWP, CTC AARs, and the Russo-Ukrainian War to provide a context in the fires community focusing on the 5RAF. He concludes that the primary causes for concern are within maintaining communications and positional data and how communications challenges pose a threat going forward regarding the 5RAF.

CHAPTER 3

RESEARCH METHODOLOGY

By researching doctrine, collective training tables, and the ATN, and USAFAS POIs, the author will address the pertinent issues that have surfaced in the U.S. Field Artillery community over the past few years.

The author will utilize a doctrinal and content analysis, qualitative analysis of CTC trends, and collective case study research methodology to address the research questions. First, in the hope of scrutinizing current U.S. Field Artillery doctrine, because doctrine serves as a start point and allows leaders the ability to begin addressing the ability to maintain firing capability in a degraded environment. Without an established concrete foundation in doctrine, the fires community lacks the necessary foundation even to begin to reference.

Second, with an analysis of current training management resources located in the ATN website, the author plans to discover what the evaluation tasks are in the CATS and METL. Doing so will gauge the training requirements and ability to maintain firing capability in a D3SOE.

Third, by exploring USAFAS NCOES, FABOLC-B, and FACCC POIs, the goal is to answer the question if leaders in the Field Artillery branch are receiving the correct education to establish and maintain firing capability in a D3SOE.

Finally, by analyzing current trends at the JRTC from the researchers' observation in an attempt to address the issues at hand. By analyzing what the CTC's feedback is to RTUs and analyzing case studies, that the author will provide understanding, visualize,

describe, and assess the way ahead to maintaining firing capability in a degraded environment.

By reviewing and researching current and historical doctrine, this thesis will answer whether or not current U.S. Field Artillery doctrine is sufficient in providing commanders the foundational knowledge and references to maintain firing capability in all environments. An all-embracing analysis of the ATN METL for all U.S. Field Artillery cannon battalions in an IBCT, Armored Brigade Combat Team (ABCT), and Stryker Brigade Combat Team (SBCT), as well as collective artillery tables, will answer the questions if units are training enough in a degraded set for the future LSCO fight. Searching through the USAFAS NCOES POIs for CMF 13 series MOS' will answer whether or not U.S. Field Artillery NCOs and officers leave their respective schools with the requisite knowledge needegd to establish and maintain firing capability in a D3SOE. Last, a detailed analysis of CTC rotations from the researcher's observation with data and AARs will serve to answer whether or not this is an actual problem or not. However, the research will address whether the artillery community is in the right or wrong direction to facilitate this change in warfare.

CHAPTER 4

ANALYSIS

The Analysis chapter will answer the question of whether or not U.S. Field Artillery doctrine, training, and leadership/education domains allow for establishing and maintaining firing capability in a D3SOE. The researcher will provide readers with a thorough analysis of a multitude of fires doctrine to address what U.S. Field Artillery leaders have access to in current doctrine as a reference. Chapter 4 will also provide readers with an analysis of the CATS and METL tasks for U.S. Field Artillery cannon units regarding analog training requirements. Third, the researcher will analyze the USAFAS POIs for NCOES, FABOLC-B, and FACCC to capture what senior NCOs and officers are learning regarding degraded TTPs. Last, Chapter 4 will examine current trends and data from the JRTC to help share an understanding of what U.S. Field Artillery Units are conducting successfully or unsuccessfully during CTC rotations regarding degraded operations.

Doctrinal Analysis of Training Circular 3-09.8, Fire Support and Field Artillery Certification and Qualification

The new Training Circular (TC) 3-09.8 dated February 2019, Fire Support and Field Artillery Certification and Qualification, consists of two chapters. The first chapter is an introduction and discusses the theory of the Field Artillery Gunnery and Gated Training strategies. TC 3-09.8 also discusses certification and qualification strategies as well as evaluations, conditions, standards, and unit training plans.[90] Chapter 2 discusses

[90] HQDA, TC 3-09.8, i.

the concept of Fire Support and Field Artillery Certification and qualification. The TC 3-09.8 acknowledges and defines denied, disrupted, and degraded conditions. Denied conditions as specified by TC 3-09.8 are access to GPS, and digital communications via space capabilities are not available.[91] Disrupted conditions are when access to GPS and digital communications via space capabilities are intermittent and are not available consistently.[92] Degraded conditions are when equipment or systems are working at reduced effectiveness, and alternative means must be utilized to maintain field artillery capabilities.[93] TC 3-09.8 also states that a degraded environment dictates the use of manual tools, near precision ammunition, and substituted procedures when equipment is not functioning correctly.[94] TC 3-09.8 dictates that field artillery battalion's gunnery programs must include performing Field Artillery tasks in many conditions to best prepare for large scale combat operations. TC 3-09.8 recommends following the Field Artillery Training Strategy and units should perform tasks using full operational capability (FOC), digital systems in a degraded capacity, and with fully degraded back up methods.[95]

Chapter 3 of TC 3-09.8 focuses specifically on howitzers and provides the methodology for training and evaluating individuals and crews on the tasks required to

[91] HQDA, TC 3-09.8, 1-9.

[92] Ibid.

[93] Ibid.

[94] Ibid.

[95] Ibid.

emplace safely, prepare for firing, execution of howitzer fire missions, and displacement of all the M109A6/A7, M119A2/A3, and the M777A2 howitzer systems.[96] This chapter of TC 3-09.8 identifies and acknowledges that cannon crew members cannot rely solely on training on fully operational systems and capabilities. The focus of the chapter is to prepare Cannon Crew members the ability to perform field artillery core tasks in large scale combat operations and the need to adapt to conduct activities against a threat from the enemy that is capable creating a denied, degraded, and disrupted space operational environment that may negatively affect or eliminate communications, navigation, position, and timing as defined above.[97] TC 3-09.8 also states that training, certifying, and qualifying with degraded digital systems and degraded manual methods is essential for the fire support community to fight and win under any conditions.[98] The researcher believes the U.S. Field Artillery community is taking the same thought process as the researcher as the importance of having the ability to perform in a D3SOE is severe since the importance of performing one's job in a degraded capacity is on the very first page in the chapter on the howitzer certification, and qualification.

Chapter 3 of TC 3-09.8 provides a simple to understand chart of priority for fire mission execution ranging from primary, alternate, contingency, and emergency. The first category is the primary meaning FOC and that the Fire Control System (FCS) located on the actual howitzer is fully operational and is communicating with the AFATDS. The

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[96] HQDA, TC 3-09.8, 2-1.

[97] Ibid., Ch. 3, 1.

[98] Ibid.

second category is alternate, meaning a degraded capacity where the FCS is functional but is not communicating with the AFATDS. The third category is contingency, meaning fully manual, and the FCS is not operational; however, back up, sights are in place. Different backup sights include a distant aiming point, collimator, or aiming poles. A distant aiming point is an easily identifiable point at least 1,500 meters away that a gunner on a howitzer can sight in on for aiming reference.[99] A collimator is a unique tool for the howitzer that a reticle, reasonably close to the observer, can be optically transferred to a position infinitely distant from the observer and therefore limits parallax.[100] Aiming poles are poles placed around the howitzer both near and far that, when aligned, provide an additional aiming point. The final category is emergency meaning fully manual and that the FCS is not operational, back up sights are not in place. However, the aiming circle or alternate laid howitzer is available. Pictured below is the table as described above.

[99] HQDA, TC 3-09.8, 4-21.

[100] Headquarters, Department of the Army (HQDA), Technical Manual (TM) 9-258, *Elementary Optics and Application to Fire Control Instruments* (Washington, DC: Government Publishing Office, December 1977), 8-27.

Table 1. Priority for Fire Mission Execution

Recommended Priority for Fire Mission Execution			
Primary	Alternate	Contingency	Emergency
FCS operational and communicating with AFATDS	FCS operational, but not communicating with AFATDS	FCS not operational, but back up sights are in place (DAP, collimator, and/or aiming poles)	FCS not operational, back up sights are not in place, but aiming circle and/or alternate laid howitzer is available
Full Operational Capability	Degraded	Manual	Manual

Source: Headquarters, Department of the Army, Training Circular 3-09.8, *Fire Support and Field Artillery Certification and Qualification* (Washington, DC: Government Publishing Office, July 2019), Ch. 3, 12.

Chapter 3 of TC 3-09.8 provides an excellent explanation for U.S. Field Artillery units on what training tasks, whose performance is either with FOC, degraded, or manual. For example, listed on page 12 are the five tasks that all 155mm howitzer crews conduct during Artillery Table IV: Execute Fires (Dry-fire). The five tasks are to conduct emergency missions, conduct howitzer fire missions, conduct direct fire missions, perform fire missions in degraded mode on the M109A6 Paladin Howitzer, and perform an Excalibur Fire mission.[101] Outlined further down are the 18 fire missions performed as well as the recommended priority for fire mission execution. Of the 18 fire missions on the list, 14 fire missions are with FOC meaning the FCS on the howitzer is operational and is digitally communicating with the AFATDS. Two fire mission's performance is in a degraded capacity meaning that the FCS on the howitzer is functional but is not

[101] HQDA, TC 3-09.8, Ch. 3, 12.

communicating with the AFATDS. Finally, two fire mission's performance is manual, meaning that the FCS on the howitzer is not operational, but back up sights are in place, or an aiming circle or alternate howitzer is available.

The tasks for 105mm howitzer crews are identical, excluding the performing fire mission in a degraded mode on the M109A6 Paladin Howitzer since this is a 155mm specific platform and the performing of an Excalibur fire mission as Excalibur is only except for three missions that are specific to 155mm Howitzers such as precision-guided munitions, Excalibur, and Family of Scatter able Munitions. Chapter 3 of TC 3-09.8 further outlines Artillery Table V: Howitzer Section Certification and Artillery Table VI: Howitzer Section Qualification. The fire missions in Artillery Table V are Identical to Artillery Table IV, except Artillery Table V is a certification conducted without live munitions. Units perform Artillery Table VI with live munitions but with only eight fire missions for both 155mm and 105mm Howitzer crews. The outlines in Chapter 3 of TC 3-09.8 identifies that six fire mission's performance is with FOC, one is degraded, and one is manual.

Chapter 5 of TC 3-09.8 approved in October 2019, outlines FDC certification and qualification. It provides Commanders, FDOs, and Fire Control NCOs a standardized method of training and qualifying the FDC personnel assigned to their organizations.[102] The tasks for FDC personnel focus on the processing of fire plans, fire missions, and determining firing data. The fire missions for FDC personnel for the Artillery Tables IV through VI are identical to howitzer section personnel. The most significant differences

[102] HQDA, TC 3-09.8, Ch. 5, 1.

outlined in Chapter 5 of TC 3-09.8 are recommending priority for computation methods. Much like Chapter 3 of TC 3-09.8 identifies recommended priority for fire mission execution, Chapter 5 is specific to FDC sections. The first recommendation is the primary meaning that the AFATDS is on the network and has the FOC. The next suggestion is alternate, meaning that digital communications are disrupted, and stand-alone digital computers are off the network. The third recommendation is contingency, meaning that digital methods of computation are unavailable, and manual computations are the primary method. The final recommendation is emergency, meaning that FDCs must now resort to Chapter 14 of TC 3-09.81, Field Artillery Manual Cannon Gunnery.[103] Pictured below is the table from Chapter 5 of TC 3-09.8, depicting the recommended priorities for computational methods described above.

[103] HQDA, TC 3-09.8, Ch. 5, 12.

Table 2. Priority for Computational Methods

Recommended Priority for Computational Methods:			
Primary	**Alternate**	**Contingency**	**Emergency**
AFATDS (on the network)	Stand Alone Digital Computers (off the network)	Manual Computations as Primary Method (Charts and Darts)	Emergency FDC Procedures Outlined in TC 3-09.81, Chapter 14
<30 Seconds to Compute	<45 Seconds to Compute	<45 Seconds to Compute	<2 Minutes to Compute
Full Operational Capability	**Digital Communication Disrupted**	Digital Methods of Computation Unavailable	Conditions Match Those Described in TC 3-09.81, Chapter 14

Source: Headquarters, Department of the Army, Training Circular 3-09.8, *Fire Support and Field Artillery Certification and Qualification* (Washington, DC: Government Publishing Office, October 2019), Ch. 5, 12.

According to Chapter 14 of TC 3-09.81, Field Artillery units are required to deliver fire at all times and that requests for fires may be received when a unit is moving or when the FDC is not yet set up.[104] During Emergency FDC procedures, the firing battery has the technical fire direction tasks of determining initial firing data to the target and preparing for the determination of subsequent data based on the observer's correction.[105] For this portion of the thesis, the author will not belabor the fine details of emergency FDC procedures but acknowledge the fact that the methods do exist in doctrine. As stated previously, the fire missions, as well as the capacity either being in FOC, degraded, or manual for which for FDC personnel in the Artillery Tables IV

[104] HQDA, TC 3-09.81, 14-1.

[105] Ibid.

through VI match those of the howitzer section personnel. The author has typically seen howitzer sections and FDC sections conduct Artillery Table VI: Section Qualification concurrently. Since Artillery Table VI is with live munitions, it is a more efficient use of Class V ammunition allocations to units.

Chapters 6 through 9 cover fire support, counterfire, radar, and survey respectively and will not receive analyzation in the research.

Chapters 10 through 12 discuss Platoon, Battery, and Battalion Collective Field Artillery Tables, respectively. Chapter 10 discusses Artillery Tables VII through XII, where Artillery Table XII is the Platoon Live Fire Qualification. Chapter 11 covers Artillery Tables XII through XV, where Artillery Table XV is the Battery Live Fire Qualification. Chapter 12 covers Artillery Tables XVI through XVIII, where Artillery Table XVIII is a Battalion Live Fire Qualification. One typical detail that Chapters 10 through 12 discuss concerning fire missions, unlike the Artillery Tables IV through VI, is the identification of performing fire missions in FOC, degraded, or manually. In Chapters 10 through 12, the doctrine says that the certifying commander determines missions fired FOC, degraded, or manually and the basis is on the published field artillery training strategy.[106] Unlike Artillery Tables IV through VI, where specific fire missions specify whether the performance is with FOC, degraded, or manually, Chapters X through XII leave the decision up to certifying commanders. The issue with this decision is the lack of standardization across U.S. Field Artillery units. In theory, unit commanders can do all fire missions with FOC according to the doctrine.

[106] HQDA, TC 3-09.8, Ch. 10, 3.

TC 3-09.8, Fire Support and Field Artillery Certification and Qualification, establishes an easy reference for tasks and missions in a FOC, degraded, and manual capacity for that of Howitzer and FDC sections. The missions are specific when addressing the type of fire mission and whether or not the task is performed either by analog or digital means. The important detail is, however, lacking for collective training for that of Field Artillery platoons, batteries, and battalions.

Doctrinal Analysis of Field Manual 3-09, Field Artillery Operations and Fire Support, April 2014

Field Manual (FM) 3-09, Field Artillery Operations and Fire Support dated April 2014, provides tactics for Field Artillery operations and fire support in ULO and is intended for commanders and staffs as the primary audience.[107] The sole purpose of the revision of FM 3-09 in 2014 was to encompass the tactics for field artillery operations and fire support planning for supporting maneuver force commanders to accomplish their objectives.[108] FM 3-09 is organized into four chapters consisting of field artillery operations, fire support, fire support, and the operations process and fire support coordination and other control measures.[109]

Beginning with Chapter 1, FM 3-09 discusses field artillery operations and its role in ULO. The field artillery's part in ULO is by massing fires in space and time on single

[107] HQDA, FM 3-09, 2014, v.

[108] Ibid., vii.

[109] Ibid., i.

or multiple targets with precision, near-precision, and area fire capabilities.[110] Chapter 1 provides leaders with a detailed and thorough understanding of the effects that the Fires WfF provides to maneuver commanders. Effects such as defeat, delay, destroy, neutralize, and suppress. These terms have various meanings depending on different organizations in the army. For example, to a maneuver commander destroy is a tactical mission task that physically renders an enemy force combat-ineffective until it is reconstituted and alternatively, to destroy a combat system is to damage it so severely that it cannot perform any function or be restored to a usable condition without being entirely rebuilt.[111] To a fire supporter destruction, in the context of computed effects of field artillery fires as defined by FM 3-09 means rendering a target out of action permanently, or ineffective for an extended period of time, and producing at least 30-percent casualties or material damage.[112] Chapter 1 also discusses planning considerations and capabilities for the field artillery in supporting offensive, defensive, stability, and defense support of civil authority's tasks. The chapter provides a plethora of planning considerations for fire supporters to reference at all levels varying from staffs, Field Artillery Brigades, and cannon field artillery battalions. For offensive tasks, the chapter goes into great detail for planning considerations for movement to contact, attack, exploitation, and pursuit. For Defensive operations, FM 3-09 provides fires planners with

[110] HQDA, FM 3-09, 2014, 1-1.

[111] Headquarters, Department of the Army (HQDA), Field Manual (FM) 1-02.2, *Operational Terms* (Washington, DC: Government Publishing Office, November 2019), 1-32.

[112] HQDA, FM 3-09, 2014, 1-3.

tasks and concerns for area defense, mobile defense, and retrograde operations. As with offensive tasks, Chapter 1 guides the organization of forces and planning factors for staff, Field Artillery Brigades, and cannon field artillery battalions. Chapter 1 provides clear guidance for organization U.S. Field Artillery units for combat and command or support relationships. The command relationships of organic, assigned, attached, operational control, and tactical control, as outlined by FM 3-09, are organized by answering calls for fire in priority, zones of fire, positioning, and fires planning.[113] The support relationships of direct support, reinforcing, general support-reinforcing, and general support are organized in FM 3-09 in the same manner as the command relationships. Chapter 1 concludes with providing considerations for the employment of the field artillery regarding the 5RAF, fire direction, counterfire, positioning, security, and sustainment. Chapter 1 affords a consolidated reference for fires planners, staffs, and commanders a multitude of factors and considerations. It does not, however, provide any sort of guidance nor any factors for considerations in a D3SOE.

Chapter 2 discusses fire support in ULO, fire support coordination organizations and key personnel, information collection and target acquisition, and fire support attack resources.[114] The chapter begins with general considerations for fire support related to the Fires WfF. The Fires WfF, as defined by FM 3-09, Chapter 2, is the related tasks and systems that provide collective and coordinated use of army indirect fires, air and missile

[113] HQDA, FM 3-09, 2014, 1-32.

[114] Ibid., i.

defense, and joint fires through the targeting process.[115] The general considerations for fire support that Chapter 2 discusses are fire support planning and the echelons of development. Typically, due to limited time, higher headquarters develop the fire support plan with refinement from subordinate units. The researcher has worked at both the company and battalion level fire support roles agrees with this statement from FM 3-09. There is a multitude of products and information required at all levels that parallel planning within the Fires WfF is paramount. The chapter also brings forth to mention that fire support elements should disseminate fires plans through a digital formatted message to reduce error probability via transmission.[116] What Chapter 2 does not discuss are ways for disseminating fires plans in a D3SOE. The discussion of providing fires that achieve desired effects highlights factors that will improve responsiveness in the chapter. One factor highlighted is streamlining the call for fire through the use of digital systems.[117] As mentioned earlier, the researcher agrees that utilizing digital systems is faster and more efficient. However, no mention of developing an alternate means other than radios are mentioned concerning fires plan dissemination on this topic in Chapter 2. Chapter 2 goes on to discuss further topics of accuracy, massing fires, target discrimination and integrating joint and multinational capabilities. Section 2 of Chapter 2 highlights fire support coordination organizations and the key personnel within said organizations. Organizations such as a fires cell at the battalion, brigade, division and corps levels, and

[115] HQDA, FM 3-09, 2014, 2-1.

[116] Ibid.

[117] Ibid.

Battlefield Coordination Detachments, and even United States Air Force, Navy, and Marine Corps elements are a few mentioned. The doctrine further discusses in length the capabilities and responsibilities for each element. Two other elements in this chapter that warrant mentioning are the army space support team and the electronic warfare element and working group. Chapter 2 provides fires planners who reference FM 3-09, a quick reference for space and electronic warfare planning. Chapter 2 mentions that the army space support team provides space-related tactical planning and support, expertise, advice, and liaison regarding space capabilities.[118] FM 3-09 further discusses a multitude of capabilities that space operations personnel provide. Capabilities like planning and integration of space assets, coordinating space support with national, service, joint, and theater resources, and providing estimates on limitations and status of space-based intelligence, surveillance, and reconnaissance, weather, navigation, and timing, and communication satellites for friendly and threat systems.[119] Next is the mention of the electronic warfare element in Chapter 2, and defining electronic warfare is military action involving the use of electromagnetic and directed energy to control the electromagnetic spectrum to attack the enemy.[120] Chapter 2 further discusses how electronic warfare elements are located at brigade, division, and corps levels and the role of integrating joint air and ground electronic warfare assets within the mission command cell.[121] Section 2 of

[118] HQDA, FM 3-09, 2014, 2-8.

[119] Ibid.

[120] Ibid.

[121] Ibid.

Chapter 2 concludes with defining duties and responsibilities of key fire support personnel. Personnel such as the FSO, targeting officer, fire support coordinator, and chief of fires. Section 3 of Chapter 2 discusses information collection and target acquisition for fire support. Much like the previous portions of FM 3-09, general considerations, planning factors, and duties and responsibilities of key personnel for this section are the points of discussion. Section 3 of Chapter 2 highlights the use of multiple assets such as observers, weapons locating radar, and unmanned aircraft play a role in information collection. Section 3 concludes with a detailed chart depicting the capabilities of field artillery weapons locating radar systems. The chart provides readers with search sectors, ranges, task organization, and optimized detection categories. Section 4 of Chapter 2 discusses fire support attack resources that include field artillery, mortars, rotary- and fixed-wing assets, and naval surface fire support.[122] This section discusses general considerations and an overview of both lethal and nonlethal effects. Provided in the section is a chart outlining cannon field artillery capability for all cannon delivery systems. The chart provides projectiles, ranges, and rates of fire. Depicted further in the section are another chart for rockets, guided rockets, and missiles. The chart provides payload, accuracy, ranges, and intended target types by munition. Also, in Section 4 of Chapter 2 are general considerations for electronic attack offensive and defensive tasks. Defensive electronic attack protects friendly personnel, equipment, or platforms while offensive electronic attack denies, disrupts, or destroys enemy capabilities.[123] The

[122] HQDA, FM 3-09, 2014, 2-19.

[123] Ibid., 2-25.

discussion of electronic attack and its uses provides fires planners planning considerations, but there is no mention of how to counter or operate in a D3SOE in this section. Chapter 2 concludes with general considerations for Naval Surface Fire Support, Air Support, and Army Aviation.

Chapter 3 of FM 3-09 discusses the role of fire support and the operations process. Section 1 discusses fire support planning, coordination, and targeting. Section 2 discusses the fire support preparation. Section 3 discusses the fire support execution. The final section discusses fire support assessment. Fire support planning in Section 1 encompasses the role of the commander's intent and the concept of operations and the importance of the commander's guidance for fire support during the operations process. Within the concept of operations, fires planners develop a scheme of fires. The scheme of fires is the detailed, logical sequence of targets and fire support events to find and engage targets to accomplish the supported commander's intent.[124] Maneuver commanders must provide clear and concise guidance on the effects he expects from fires.[125] During the planning portion, fires planners must analyze, allocate, and schedule fires to describe how fires will facilitate the actions of the maneuver force and how they meet the commander's guidance for fires. Section 1 of Chapter 3 further illustrates the principles and planning factors in general terms on how fire support planning employs capabilities and the importance of supporting the overall maneuver plan. Section 1 concludes with the targeting process and how this process coexists during the planning process. Section 2

[124] HQDA, FM 3-09, 2014, 3-1.

[125] Ibid.

discusses fire support preparation and the relation to improving success for friendly forces. The role of rehearsals and the types of rehearsals serve as the emphasis in Section 2. Section 2 discusses the types of digital rehearsals conducted during the fire support preparation process. The types of digital rehearsals provided are the levels I-III digital rehearsals and the integrated digital and tactical fire support and field artillery rehearsals. Section 2 lacks any discussion of conducting analog rehearsals to support the maneuver plan. Section 3 of Chapter 3 discusses general considerations for fire support execution. Fires planners can find factors for fire support for offensive tasks that enable surprise, concentration, tempo, and audacity. Concerning defensive tasks, fires planners can find considerations for preparation, security, disruption, massing, flexibility, maneuver, and operations in depth within Section 3. Section 3 also discusses considerations for fire support in defense support to civil authorities. Section 3 concludes by discussing particular concerns for fire support. This section discusses the synchronization of fires assets, supporting decisive, shaping, and sustaining operations, and multinational operations. The final part of Chapter 3 is about fire support and the role during the assessment portion of operations. Section 4 discusses measures of performance and effectiveness and how assessments help commanders determine progress toward accomplishing tasks and achieving objectives and end state.[126] Section 4 concludes with how the fires running estimate plays a pivotal role throughout the operations process and not just during the final assessment phase.

[126] HQDA, FM 3-09, 2014, 3-18.

The final Chapter for FM 3-09 discusses Fire Support Coordination. Section 1 of Chapter 4 discusses the role of fire support coordination measures and how these measures enable rapid engagement of targets and providing safeguards for friendly forces.[127] Section 2 of Chapter 4 discusses boundaries, phase lines, and other fire support considerations. Section 3 of Chapter 4 discusses target acquisition control and airspace coordination measures when developing fire support plans. Chapter 4 provides fires planners with the doctrinal verbiage and graphical depiction on fires overlays on how to expedite fires in support of a maneuver plan and safeguards that allow for maximum effects on the enemy without hindering friendly forces.

FM 3-09, dated April 2014, is an excellent reference for all fire support and field artillery officers for planning operations in support of ULO. FM 3-09 provides planning considerations for fire supporters at all levels from the company to corps as well as incorporating enablers into the fires plan to support the maneuver commander. What FM 3-09 does not do, however, is provide planning factors when operating in a D3SOE and how fire supporters and U.S. Field Artillery units can capitalize and ensure the establishment and maintenance of the Fires WfF during planning, preparation, execution, and assessment.

Doctrinal Analysis of Army Doctrinal Publication 3-19, Fires

Army Doctrinal Publication 3-19, Fires, defines and describes the Fires WfF in terms of its primary tasks, capabilities, features, and processes, and describes the integration of skills and their associated effects through the targeting and operations

[127] HQDA, FM 3-09, 2014, 4-1.

process.[128] ADP 3-19 forms the foundation for training and Army Education curricula on fires.[129] According to ADP 3-19, fires include lethal and nonlethal effects, as delivered by Army, joint, and multinational capabilities.[130] ADP 3-19 acknowledges in the preface that the publication is broad to cover fires as a complete entity and gives equal treatment to the diverse assets that contribute to the Fires WfF.[131] ADP 3-19 is organized into three chapters, which include an introduction to fires, the execution of fires across the domains, and the integration of army, multinational, and joint fires assets.[132]

Chapter 1 of ADP 3-19, being the introduction, defines for readers the definition of the Fires WfF and the role of fires in ULO. Chapter 1 is where the publication first mentions denying, degrading, and disruption. The publication describes the effects concerning the enemy in the sense that the enemy will attempt such actions.[133] Chapter 1 of ADP 3-19 addresses the fact that units must prepare to operate in a D3SOE and ensure commanders can always utilize fires assets.[134] Much like FM 3-09, Chapter 1 of ADP 3-19 describes the fire's tasks required to create the desired effects to achieve the maneuver

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[128] Headquarters, Department of the Army (HQDA), Army Doctrine Publication (ADP) 3-19, *Fires* (Washington, DC: Government Publishing Office, July 2019), iii.

[129] Ibid.

[130] Ibid.

[131] Ibid.

[132] Ibid., i.

[133] Ibid., 1-5.

[134] Ibid.

commander's objectives.[135] Duties to include targeting, airspace planning and management, multinational integration, and air and missile defense planning and integration to highlight a few. Chapter 1 discusses the Fires WfF, and the ways fires provide effects to shape the operational environment. Last, the chapter elaborates on how fires capabilities support ULO in shaping operational environments, preventing conflict, prevailing during large-scale ground combat, and consolidating gains.[136]

Chapter 2 of ADP 3-19 define and describe tasks and capabilities commanders use to execute fires in the air, land, sea, space, and cyberspace domains as well as the information environment. Chapter 2 mentions D3SOE concerning offensive space control. In this context, the publication is referring to the offensive operations conducted for space negation meaning the measures taken to deceive, disrupt, degrade, deny, or destroy space systems.[137] The chapter does acknowledge that offensive space control actions are actions targeting enemy space capabilities and that these actions are, in fact, a form of fires.[138] Chapter 2 also discusses how the space running estimate encompasses predicted periods when GPS is degraded, which may affect PNT accuracy, employment times, and locations for GPS aided munitions. This plays into effect on U.S. Field Artillery units because these conditions affect the use of precision munitions. Thus units would require utilizing conventional munitions during these periods of disruption,

[135] HQDA, ADP 3-19, v.

[136] Ibid., 1-5.

[137] Ibid., 2-6.

[138] Ibid.

degradation, or denial. Even though this is not an effect from the enemy per se, Chapter 2 of ADP 3-19 addresses, demonstrates awareness and provides planning considerations for units even with friendly D3SOE conditions. There is also discussion on surface-to-surface, air-to-surface fires, and surface-to-air fires. Surface-to-surface indirect fires include cannon, rocket, and missile systems, as well as mortars organic to maneuver elements.[139] Air-to-surface fires include fixed-wing aircraft, rotary-wing aircraft, and unmanned aircraft systems that provide lethal and nonlethal effects, standoff weapons, and target acquisition capabilities that detect and create integrated effects against adversaries.[140] Surface-to-air fires, as defined by ADP 3-19, include active defense weapons that are employed in both area and point defenses to defend friendly forces, fixed and semi-fixed assets, population centers, and critical infrastructure.[141] Chapter 2 concludes with a discussion on the roles of special operations and information operations concerning the Fires WfF.

Chapter 3 of ADP 3-19 discusses the processes that a commander and staff organizations utilize for synchronizing fires concerning the force.[142] Like FM 3-09, Chapter 3 discusses fire support planning and the integration of fires into the operations process. Chapter 3 highlights such processes as airspace planning and integration, multinational fires integration, fires preparation, and assessment. The chapter describes

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[139] HQDA, ADP 3-19, 2-1.

[140] Ibid., 2-2.

[141] Ibid., 2-4.

[142] Ibid.

how intelligence preparation of the battlefield (IPB) and information collection utilized by fires planners for prioritizing targets, achieving desired effects, and the available resources for commanders.[143] Chapter 3 concludes with the incorporation of air and missile defense planning and integration and gives readers planning considerations and capabilities that directly correlate with planning, preparing, executing, and assessing as part of the operations process.[144]

ADP 3-19 dated July 2019 addresses possible planning factors and considerations for operating in a D3SOE. This publication provides readers with the acknowledgment of preparing to operate in a contested environment if even from when friendly asset capabilities could deny, disrupt, or degrade the operational environment specifically when discussing munitions such as precision vice conventional. The preface acknowledges that the publication provides readers with a broad conceptual basis for the Fires WfF but lacks addressing possible issues when operating in a D3SOE.

Doctrinal Analysis of Army Training Publication 3-09.50, The Field Artillery Cannon Battery

The organization of ATP 3-09.50 consists of chapters on key personnel, key considerations, reconnaissance, laying and measuring, battery defense, hasty survey techniques, fire commands, minimum quadrant elevation, unit considerations, and deployment. Several appendices accompany the ATP, which consist of precision munitions and ammunition management, sample mission checklists, common mistakes

[143] HQDA, ADP 3-19, 2-4.

[144] Ibid., 3-13.

and malpractices, forms, aiming circle and M2 compass declination procedures, and killer junior fuze techniques for direct fire. Chapter 3 of ATP 3-09.50 mentions that the loss of space-based communications due to enemy activity remains a significant concern for cannon batteries conducting military operations; however, this is the only mentioning of such a possible hazard.[145]

In the second chapter, key considerations, readers see the first mentioning of operating in a degraded capacity. Section 2-25 of the ATP 3-09.50 addresses that during some types of degraded howitzer operations, the FDC may assume direct control of technical fire direction if the digital control system of a howitzer becomes degraded or inoperative.[146] Noted next is that the preferred method requires an operational howitzer to locate next to the degraded howitzer and the degraded howitzer uses the operational howitzer's firing data.[147] Chapter 2 of ATP 3-09.50 also mentions that in the event when an FDC is providing technical data to one or more howitzers, secondary checks with independent means are used, for example, the secondary independent check for the AFATDS computing date is by verifying the howitzer location and the target location. Upon data verification and correct input into the AFATDS pending no significant database changes, the data is safe.[148] Chapter 2 of ATP 3-09.50 also informs battery

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[145] Headquarters, Department of the Army (HQDA), Army Training Publication (ATP) 3-09.50, *The Field Artillery Cannon Battery* (Washington, DC: Government Publishing Office, May 2016), 3-9.

[146] Ibid., 2-5.

[147] Ibid.

[148] Ibid.

personnel on the preparation of utilizing hasty survey techniques to establish directional and positional control in urban operations due to magnetic instrument impairment.[149]

Chapter 4 of ATP 3-09.50 addresses degraded digital communications in the event of degradation. The possible means of transmitting fire commands are digital, degraded digital, and voice.[150] Section 4-74 highlights to battery personnel that an alternative to voice communications is through degraded digital communications. Degraded digital communication uses the AFATDS purely as a technical fire direction computer and transmits the fire commands by voice.[151] Of one or more howitzers lose digital communications, the FDC directs all howitzers to ignore gun display unit data and take all fire commands by voice via the FDC.[152] Chapter 4 addresses all the necessary steps for operating the GLPS, which is a digital howitzer laying and measuring tool and M2A2 Aiming Circle, which functions off of the magnetic force of the earth. So ideally, even in a D3SOE, battery personnel have a doctrinal reference to aid in laying and occupying a firing position with both systems.[153]

Chapter 7 of ATP 3-09.50 provides battery personnel with a TTP for repeating and correcting fire commands. While operating in degraded operations, the FDC designates a section of the firing element to read back all voice fire commands to ensure

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[149] HQDA, ATP 3-09.50, 2-7.

[150] Ibid., 7-1.

[151] Ibid., 4-20.

[152] Ibid.

[153] Ibid., 4-5.

the correct receipt of fire commands.[154] Chapter 10 of ATP 3-09.50 guides battery personnel to conduct communications rehearsals, including degraded operations.[155]

ATP 3-09.50 provides battery personnel, an example DA Form 5969, Section Chief's report for 105mm and 155mm howitzers. The purpose of the DA Form 5969 is even though the howitzer's automation system typically provides the information in the form, degraded operations require manual record-keeping, which the DA Form 5969 captures.[156]

ATP 3-09.50 provides cannon battery personnel with TTPs for operating in a degraded capacity. The primary focus is regarding FDC's direct control of technical fire direction. The ATP 3-09.50 also provides readers considerations for degraded TTPs while operating in urban environments and also degraded digital communications as a means for transmitting fire commands should digital connectivity worsen. The ATP 3-09.50 provides sample forms for individual howitzer sections to annotate data typically captured via digital means. What ATP 3-09.50 does not address a lot of is cannon battery TTPs for operating in a degraded operating environment. The focus is primarily on TTPs for FDC crews to send fire commands should digital communications degrade.

Doctrinal Analysis of ATP 3-09.23, Field Artillery Cannon Battalion.

ATP 3-09.23, Field Artillery Cannon Battalion, consists of seven chapters that discuss the organizational framework, mission command, planning, detecting and

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[154] HQDA, ATP 3-09.50, 7-7.

[155] Ibid., 10-3.

[156] Ibid., D-9.

locating surface targets, fires delivery, operations, and sustainment at the field artillery battalion level. There are also two appendices comprised of field artillery battalion operations order templates and composite battalion information. Finally, there is a table that provides examples for a field artillery battalion planning processes, artillery raid checklist, and daily ammunition requirements.

Chapter 1 of the ATP 3-09.23 discusses the field artillery battalion organizational framework. In this chapter, fires personnel can identify duties and responsibilities ranging from target acquisition personnel, primary and assistant staff members, and support personnel. It is in Chapter 1 where readers can identify responsibilities on degraded operations. This chapter tasks the battalion FDC as the responsible entity for establishing and practicing standard procedures for FDC operations in a degraded mode.[157] Even more specifically identified in Chapter 1 is the battalion FDO's responsibility for establishing procedures and training personnel to accomplish both tactical and technical fire direction in a degraded mode.[158] Upon review of Chapter 1, the two tasks identified above are the only tasks and duties mentioned.

Chapter 2 of ATP 3-09.23 discusses Field Artillery Battalion Mission Command, such as command and support relationships, command post operations, and communications. In the final section of the chapter, while discussing communications, the ATP 3-09.23 addresses internal networking in a Field Artillery Battalion. Paragraph

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[157] Headquarters, Department of the Army (HQDA), Army Training Publication (ATP) 3-09.23, *Field Artillery Cannon Battalion* (Washington, DC: Government Publishing Office, September 2015), 1-4.

[158] Ibid., 1-15.

2-92 suggests using battalion command digital networks for fire support planning and coordination between field artillery elements, for mutual support unit operations, and for tactical and technical fire direction to reinforcing artillery units.[159] Also, the network control station is the battalion FDC and that the establishment of the network as a voice network during degraded operations is one of the possible internal networks required for normal operations.[160] The internal networking TTP suggested above is the only mention of degraded operations while discussing mission command in Chapter 2.

In Chapter 5, Deliver Fires, of ATP 3-09.23, there is a section on fire mission requests via digital and voice means. It is here where battalions can find recommendations on digital field artillery technical rehearsals. Paragraph 5-6 recommends rehearsing digital fire missions along with the entire data link, under the same digital conditions anticipated for actual operations like extended communications distances, surge digital traffic capacity, and degraded operations.[161] Fires leaders should not take this suggestion lightly as varying conditions can impede the functionality of digital equipment, and a proper rehearsal mimicking multiple variables can only allow for mitigating factor identification. Chapter 5 also guides technical fire direction during degraded operations. Field Artillery battalions perform technical fire direction on the howitzer, and the FDC assumes a back-up technical fire direction role. Paragraph 5-29 identifies that during the degraded mode, the FDC will exercise direct technical control of

[159] HQDA, ATP 3-09.23, 2-15.

[160] Ibid.

[161] Ibid., 5-2.

howitzers.[162] There is a section in Chapter 5 regarding degraded survey operations for field artillery battalion leaders to reference. Here is the acknowledgment that degraded conditions for survey operations may occur due to the unavailability of satellite systems of inoperable automated position or direction systems.[163] This paragraph gives suggestions for survey requirements in offensive and defensive operations and that units must use hasty survey techniques during degraded operations or when adequate survey control is not available.[164]

Chapter 6 of ATP 3-09.23 discusses Field Artillery Battalion Operations. Planning considerations for the primary field artillery tasks in support of static positions, specifically the employment of fires, provides a reference for field artillery battalion leaders. Paragraph 6-134 discusses the determination of the impacts of the terrain on specific types of howitzers, consideration of immediate and intervening crests, and the consideration of the ability to access survey data and aiming posts dependent on weapon systems and the availability to conduct degraded operations.

Much like ATP 3-09.50 The Field Artillery Cannon Battery, ATP 3-09.23 provides fire supporters with a doctrinal reference for some applications regarding degraded operations and planning factors. Similarly, in both publications, the emphasis is on FDC TTPs. The TTPs addressed in ATP 3-09.23 pertain to tactical and technical fire direction duties and responsibilities in a degraded capacity, but one difference in the ATP

[162] HQDA, ATP 3-09.23, 5-5.

[163] Ibid., 5-16.

[164]Ibid.

3-09.23 is the addressing of internal networking at the battalion level during degraded operations. The address of internal networking is because the equipment sets differing between the battery and battalion level. Another differing variable at the battalion level addressed in ATP 3-09.23 is the mentioning of conducting rehearsals at the battalion level to mimic conditions for actual operations. The one crucial condition worth mentioning is conducting digital rehearsals under degraded operating conditions. Last, the ATP 3-09.23 dictates to readers during static positions and fires employment to considering capabilities and effects on the weapons system's ability to conduct degraded operations.

Doctrinal Analysis of TC 3-09.81, Field Artillery Manual Cannon Gunnery

Training Circular 3-09.81, Field Artillery Manual Cannon Gunnery is perhaps the most well-versed doctrinal reference regarding degraded operations, as in the title of the publication is on manual cannon gunnery. The TC 3-09.81 includes step-by-step instructions for manually solving gunnery problems applied within the framework of decisive action and ULO and applies to army personnel at the battalion or battery level responsible for delivering field artillery fires.[165] TC 3-09.81 explains all aspects of the manual cannon gunnery problem and presents a practical application of the science of ballistics and how they pertain to artillery fires.[166] The TC 3-09.81 organization comprises of 15 chapters and supporting appendixes A through H.[167] Chapters 1 and 2

[165] HQDA, TC 3-09.81, xxiii.

[166] Ibid.

[167] Ibid., xxv.

provide fire direction personnel with an introduction to the gunnery problem and associating relationships of the gunnery team, and FDC member's responsibilities and organization within the battery.[168] Chapters 3 and 4 describe the practical application of the science of ballistics, muzzle velocity management, and guidance in establishing an order of preference when managing muzzle velocity.[169] Chapter 5 details the procedures for determining fire orders, message to observers, and fire commands. Chapter 6 describes the elements to the solution of the gunnery problem by determining chart data.[170] Chapter 7 describes the use of TFTs and GFTs in the solution of the gunnery problem.[171] TFTs are booklets containing pages of chart like data and graphs where GFTs are slide rule like instruments for also determining fire direction data manually. Chapter 8 outlines the procedures to account for differing altitudes between targets and firing elements, where Chapter 9 details the record of fire use and the necessary mission processing for high explosive and illumination ammunition.[172] Chapters 10 and 11 discuss means of determining cumulative errors, registration explanation, and the applicability to manual gunnery, and meteorological techniques to account for non-standard conditions in achieving first-round effects.[173] Chapters 12 and 13 explain

[168] HQDA, TC 3-09.81, xxv.

[169] Ibid.

[170] Ibid.

[171] Ibid.

[172] Ibid.

[173] Ibid.

techniques used to enhance survivability on the battlefield and TTPs required for special munitions.[174] The last two chapters provide guidance on delivering fire in emergencies, determining safety, and executive officer minimum quadrant elevation.[175] The associated appendices allow fire direction personnel a reference for standard operating procedures, troubleshooting TTPs, planning ranges, firing data determination with graphical firing tables, and special munition fire missions.[176] The TC 3-09.81 is a doctrinal reference solely aimed at providing fire direction personnel and field artillery leaders the foundation for conducting manual gunnery TTPs. The content and applications provided in the TC 3-09.81 allow U.S. Field Artillery units a single-source reference for solving the gunnery problem without the need for automated systems. Thus, allowing the cannon unit FDCs the ability to establish and maintain firing capability in a D3SOE.

Doctrinal Analysis of ATP 3-09.02, Field Artillery Survey

The ATP 3-09.02, Field Artillery Survey, is a guide for commanders, survey personnel, and personnel whose duties pertain to planning, supervising, and performing field artillery surveys and provides techniques for instruction and employment for survey sections, guidance and reference in survey principles, and TTPs used to operate and maintain equipment.[177] The survey manual applies to Field Artillery commanders, staff,

[174] HQDA, TC 3-09.81, xxv.

[175] Ibid.

[176] Ibid.

[177] Headquarters, Department of the Army (HQDA), Army Training Publication (ATP) 3-09.02, *Field Artillery Survey* (Washington, DC: Government Publishing Office, February 2016), vii.

at the Division Artillery, Field Artillery Brigade, and Battalion levels and below. The ATP 3-09.02 organization comprises chapters on duties and responsibilities, survey planning and operations, survey computer systems, survey methods, and GPS applications and systems.

Immediately in Chapter 1 under responsibilities, the survey manual highlights that the current operational environment and emerging threats require the fires community to conduct GPS denied and or systems degraded operations.[178] Additionally, ATP 3-09.02 tasks maneuver operations officers and Force Field Artillery Headquarters Commanders with issuing guidance for operations during GPS denied and other degraded conditions.[179] By establishing the fact early in the survey manual of a real-world GPS denied environment that the U.S. Army's peers possess, U.S. Field Artillery surveyors and planners can take heed to such threats early in the surveying planning and processes.

Chapter 3 of ATP 3-09.02 under survey methods also addresses survey methods in a GPS denied or degraded environment. The survey manual states that in a GPS denied or degraded environment requires establishing a survey before occupation vice in a GPS permissive environment; only initialization survey control points are critical throughout the area of operations. However, survey control points in position areas for artillery are not a priority.[180] Paragraph 3-23 also states that in a GPS denied or degraded environment, commanders will have to assume risk regarding survey accuracies, and it is

[178] HQDA, ATP 3-09.02, 1-2.

[179] Ibid., 1-3.

[180] Ibid., 3-5.

inherent on all field artillerymen and leaders to advise the commander of the effect of inaccuracies regarding fire support.[181] Chapter 9 of the survey manual also discusses electronic warfare, spoofing, and anti-spoofing TTPs regarding the Defense Advanced GPS receiver (DAGR). Paragraph 9-33 advises readers that hostile parties may attempt to imitate, also known as spoofing, GPS satellite signals to create errors in navigation and position data.[182] The survey manual provides information that the employment of crypto keys helps protect against such attempts and that when operating the DAGR in a secure environment.[183]

Chapter 8 of ATP 3-09.02 pertains to the Improved Position and Azimuth Determining System (IPADS) and IPADS-G. The IPAD is a self-contained inertial surveying system that rapidly determines accurate position, altitude, and azimuth.[184] The IPADS and IPADS-G is the item currently on U.S. Field Artillery units MTOE for establishing a survey. The IPADS-G current implementation is in ground vehicles for survey operations and can achieve 4 meters circular error probability in position, 2 meters probable error in altitude, and 0.4 mils probable error in azimuth.[185] Since the IPADS and IPADS-G do not require a GPS, due to the self-contained inertial surveying system, it is capable of providing a survey in a D3SOE, pending initialization procedures done

[181] HQDA, ATP 3-09.02, 3-5.

[182] Ibid., 9-9.

[183] Ibid.

[184] Ibid., 8-1.

[185] Ibid., 8-2.

correctly.[186] However, with GPS, the IPADS-G is flexible in initialization methods, which allows for seamless transitions between stationary and on-the-move methods. The capabilities of the IPADS and IPADS-G being able to function with or without GPS allows for survey operations in a D3SOE and allowing for U.S. Field Artillery Units accurate fires during ULO.

Chapter 7 of ATP 3-09.02 is perhaps the most astonishing as it deals with types of survey methods available to U.S. Field Artillery units in all operating environments. The last paragraph discussed the IPADS and IPADS-G as the primary means for providing survey control. Other ways of establishing a survey are with the Nikon NE-102 Theodolite, the Navigational System Tracking and Range (NAVSTAR) GPS, a Handheld Terminal Unit, and Astronomic Observation.

The NAVSTAR GPS is a space-based navigation and positioning system that provides accurate three-dimensional positioning and velocity information and time.[187] Approximately 30 satellites providing 24-hour worldwide coverage make up the NAVSTAR GPS space segment.[188] Field artillery surveyors utilizing a DAGR allows for initiating surveys when existing survey control is not available. [189] When using the GPS method for establishing a survey, it is essential to check position data by another

[186] HQDA, ATP 3-09.02, 8-2.

[187] Ibid., 7-1.

[188] Ibid.

[189] Ibid.

independent means such as a second DAGR, an accurate map spot, or coordinates from an IPADS or IPADS-G.[190]

Another way of establishing a survey is with a Handheld Terminal Unit. A surveyor with a Handheld Terminal Unit and a trigonometric list of survey control points provide the means to compute and determine accurate azimuths.[191] According to Paragraph 7-7 of ATP 3-09.02, azimuth is the most critical data for firing and target acquisition units.

The last way of providing a survey discussed in this thesis is that utilizing Astronomic Observations. Astronomic Observations serve multiple purposes. Astronomic Observations provide surveyors with the ability to check azimuths of any line in a survey, provide orienting azimuths for cannons and fire control equipment, determine azimuths for declinating aiming circles, and provide orienting azimuths for radars and observation posts.[192] The three methods of determining azimuth by astronomic observation are artillery astronomic observation, hasty astronomic observation, and simultaneous observation.[193] Artillery Astronomic Observation utilizes the sun, moon, or other stars for providing survey data to U.S. Field Artillery units in a D3SOE. An M2A2 Aiming Circle relies solely on the magnetic force of the earth and can provide survey control via Astronomic Observation. Astronomic Observation is not as accurate as some of the

[190] HQDA, ATP 3-09.02, 7-1.

[191] Ibid., 7-2.

[192] Ibid.

[193] Ibid.

means mentioned above, like IPADS-G or GPS, but it still provides U.S. Field Artillery units the ability for an accurate survey and, in turn, accurate fires in a D3SOE.

ATP 3-09.02 discusses U.S. Field Artillery Survey operations, planning factors, and TTPs for establishing survey control for field artillery organizations. The publication highlights the inevitable threats the U.S. Army's peers possess as far as degrading and denying space-based GPS functions and equipment sets. The ATP 3-09.02 provides field artillerymen with an entire chapter on providing a survey without the requisite for digital equipment that is potentially vulnerable in a D3SOE. The chapter discusses means of providing a survey via the stars, sun, and moon with various pieces of equipment such as a theodolite or an aiming circle, which is vital for U.S. Field Artillery units in a D3SOE.

Doctrinal Analysis of FM 3-09, Fire Support and Field Artillery Operations

Earlier in this chapter, an analysis of FM 3-09, Field Artillery Operations and Fire support dated April 2014, a discovery that a lack of emphasis on operating in a D3SOE is evident. The FCoE is currently working a rewrite of the FM 3-09, and for this research, the draft version as of March 2020 will serve as a way ahead for the fires community regarding FM 3-09. One monumental step towards operating in a D3SOE that the FCoE is resolving is in the new FM 3-09, there is an entire appendix, Appendix C, dedicated to Denied, Degraded, and Disrupted Operations. This additional chapter discusses the types of denied, degraded, and disrupted operations and training for these types of conditions. The new Appendix C also discusses the five requirements for accurate predicted fire during denied, degraded, and disrupted operations. The introduction of Appendix C emphasizes that commanders must drive training conditions based on the expected

conditions to effectively operate in a denied, degraded, and disrupted environment.[194] Appendix C serves as an example of how U.S. Field Artillery units can plan and train to maintain firing capabilities when all capacities are not fully functional.[195]

Section 1 of Appendix C discusses the types of denied, degraded, and disrupted conditions. Highlighted in Section 1 is how enemies and adversaries seek to contest the use of the information environment to diminish the U.S. and multinational forces' capabilities.[196] Specifically, regarding communications, Section 1 emphasizes that enemies and adversaries will deliberately attempt to deny friendly use of the electromagnetic spectrum, space, cyberspace, and terrestrial systems and how the U.S. Army is heavily reliant on joint advanced communications, such attacks are a central component that adversaries will focus on.[197] Other reasons for U.S. Field Artillery units to operate in a degraded capacity are due to maintenance or system faults, and Section 1 of Appendix C addresses units to develop TTPs and SOPs to implement to maintain firing capability. Section 1 of Appendix C discusses GPS denied operations, and the persistent disruption of GPS is one of the greatest threats. The GPS denied operations section discusses TTPs for units to implement should GPS become disrupted. The best solution is with anti-jamming equipment as well as utilizing the human body to block the

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[194] Headquarters, Department of the Army (HQDA), Field Manual (FM) 3-09, *Fire Support and Field Artillery Operations* (Washington, DC: Government Publishing Office, April 2020), C-1.

[195] Ibid.

[196] Ibid.

[197] Ibid.

signal and by slowly pivoting 90 degrees every two minutes until GPS signal regains.[198] The final portion under GPS denied operations addresses that field artillery systems are capable of operating for limited durations in a GPS denied environment and that units must prepare and train to execute using inertial navigation systems, maps, aiming circles, and compass when necessary.[199] The final portion in Section 1 of Appendix C discusses the loss of network connectivity and how enemy cyber electronic magnetic activity can disrupt networks affecting essential means of communications. The emphasis of establishing, disseminating, and rehearsing primary, alternate, contingency, and emergency communications to maintain communications and firing capability informs field artillerymen of threats and TTPs to mitigate such attacks.

Further discussing the loss of network, Section 1 addresses that digital communications are the primary means for transmitting fire commands, and should connectivity become degraded, the degraded digital aspect discussed earlier becomes alternate. Also, voice, courier, and liaison personnel become part of the communications plan should such conditions degrade or deny the digital and network connectivity.[200] The final portion under Section 1 addresses training for a denied, degraded, and disrupted environment. In the training section of Chapter 8, there is mention that units must train for conditions to include degraded networks, degraded positioning, navigation and

[198] HQDA, FM 3-09, 2020, C-2.

[199] Ibid.

[200] Ibid.

timing, degraded FCSs, and degraded precision fires.[201] Paragraph C-14 emphasizes that realistic training coupled with increased repetitions improves the ability of U.S. Field Artillery units to manage operational contingencies and maintain firing capability.[202]

Section 2 contains the bulk of Appendix C and describes the five requirements for accurate predicted fire during denied, degraded, and disrupted operations and TTPs U.S. Field Artillery units can utilize to maintain the requirements in a D3SOE.

The first requirement is accurate target location and size. Appendix C states that when in a degraded capacity, observers must rely on terrain association, maps, compass, protractor, and observed fire fans to improve accuracy and speed.[203] In a mounted fire support vehicle, under GPS degraded conditions, the vehicle has an inertial location and navigational system that allows observers to meet the first requirement.[204] Whether in a mounted or dismounted capacity, Section 2 of Appendix C addresses possible means for observers to determine accurate target location and size in a degraded, denied, or disrupted environment.

The second requirement for accurate predicted fire is accurate firing unit location. This portion of Appendix C mirrors what the discussion earlier when analyzing ATP 3-09.02, Field Artillery Survey. The TTPs like hasty survey through graphic resection or traverse and artillery astronomic observation are ways to provide accurate firing unit

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[201] HQDA, FM 3-09, 2020, C-3.

[202] Ibid., C-2.

[203] Ibid., C-4.

[204] Ibid., C-5.

location when in a D3SOE. One highlight, though, is the acknowledgment that there is no longer a dedicated MOS solely for survey operations and the need to train non-survey personnel on how to operate the survey equipment.[205]

The third requirement for accurate predicted fire is accurate weapon and ammunition information. Discussed earlier in the literature review, the requirement of accurate weapon and ammunition information is not very susceptible to effects in a degraded, denied, or disrupted environment except for AFATDS network issues. Section 2 of Appendix C discusses the procedures to apply weapons information manually. The techniques are those found in TC 3-09.81, Manual Cannon Gunnery, like utilizing plotting boards, TFTs, GFTs, and range deflection protractors to calculate fire control data in a degraded environment.

The fourth requirement for accurate predicted fire is accurate meteorological information. The Computer Meteorological Data-Profiler is a weather measurement system developed to provide data to support artillery and target acquisition units.[206] Other than checking meteorological messages for errors and discrepancies in a D3SOE, Appendix C refers readers to the manual computation of meteorological data. Specifically, for manual meteorological procedures, Paragraph C-60 informs readers to use a DA form 4200, Met Data Correction Sheet, as outlined in TC 3-09.81.

The final requirement for accurate predicted fire is accurate computational procedures. Automated and manual techniques allow for accurate and timely delivery of

[205] HQDA, FM 3-09, 2020, C-5.

[206] Ibid., C-9.

fire, and the balance between accuracy, speed, and safety is inherent in computational procedures.[207] Regarding degraded operations, Appendix C mentions that during some types of degraded howitzer operations, a battery or platoon FDC can assume direct control of technical fire direction and send firing data to the howitzers.[208] Appendix C does mention that manual and analog techniques are a form of position improvement, and they should not impede the setup or processing with automated means, and manual backups serve as a basis of an independent check to an automated solution.[209]

The appearance that senior field artillery leaders are aware of the possible threats that enemies and adversaries possess to hinder the ability to maintain firing capability in a D3SOE is evident. The evidence of said claim is in the draft version of the new FM 3-09 dated August 2019. The draft version contains an entire chapter dedicated to degraded, denied, and disrupted environments and their effects on the five requirements for accurate predicted fire. Doctrine writers are taking a step in the right direction regarding emphasizing field artillery doctrine for artillerymen to reference. The repeated mention throughout the new FM 3-09 of peer adversaries' capabilities and threats provides readers as to why training on analog and degraded capacities is paramount.

Analysis of the CATS

The second portion of Chapter 4 is by analyzing what the ATN provides for U.S. Field Artillery cannon battalions in ABCTs, IBCTs, and SBCTs. By examining Training

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[207] HQDA, FM 3-09, 2020, C-11.

[208] Ibid.

[209] Ibid.

Evaluations and Outlines (TE&Os) in the CATS and METLs that the ATN website provides.

The research of 105mm and 155mm Howitzer batteries organic to IBCTs, ABCTs, and SBCTs will analyze four different tasks and recommend solutions for each. The first task will be task number 06-BTRY-3001, Occupy a tactical Area.[210] The task conditions recommend that "Some iterations of this task should be conducted in a degraded or GPS denied environment." All subtasks are not relevant to the argument made for a degraded environment, excluding one. Subtask 7 states that the battery performs position improvement. It further discusses the likes of erecting camouflage, concealing equipment, preparing and designating alternate positions, organizing logistic elements so that they may operate freely and not interfere with other operations, and conducts position improvement per the Tactical Standard Operating Procedures (TSOP) and doctrinal publications. The researching of all respective units TSOPs did not occur; however, a review of the doctrinal references for the associated task did receive analyzation. Upon examination, the only mention of position improvement referred to preparing defensive positions and not that of performing in a degraded capacity. A possible interpretation of such measures is that the unit commander places discretion in their respective TSOPs to establish what tasks are associated with position improvement.

The second task reviewed was task 06-BTRY-3026, Conduct a towed Artillery Occupation. This task, much like the previous falls into the same categories of degraded

[210] Army Training Network, "Combined Arms Training Strategy," accessed September 29, 2019, https://atn.army.mil/ATNPortalUI/CATS/ViewCats?catsIdentifier=7af10d86-e2fa-4efd-b9c0-2887b634bded.

capacity and position improvement. The task suggests that some iterations "should" be done in a degraded environment as opposed to "will" be conducted in a degraded environment. Subtask 6 notes that "The unit continues with position improvement, camouflage nets, and distribution of ammunition as required." There appears to be a lot of conditions and standards open for interpretation with not enough focus on performing in a degraded capacity.

The third task reviewed was task 06-BTRY-5424, Process fire missions. For this task, the analysis of two individual supporting tasks received further analysis. The included tasks were 061-13B-3001, Initialize the Digital Fire Control System (DFCS), and 061-300-1010, Prepare Fire Mission Processing Data in an AFATDS. The DFCS is a digital system on the howitzer itself, and the AFATDS is the digital system located in the FDC for computing technical firing data. There is no mention of performing fire missions on the howitzer or FDC with non-digital means, thus again leaving the degraded training at the discretion of the unit commander.

The final task analyzed was task 06-SEC-5017, Conduct Howitzer Fire Missions. This task will also focus on several supporting individual tasks. Seven associated individual tasks highlight the operation and fire mission processing with a Gun Display Unit and the Gun Display Unit-Replacement. The Gun Display Unit and the Gun Display Unit-Replacement are older digital systems for the howitzer section. Again, there is no emphasis placed on mandating performance in a degraded capacity. The common trend observed while analyzing the CATS and METL for this type of unit, in particular, is the use of the word "should" and multiple mandated tasks associated with utilizing a digital piece of equipment. It requires a mature and disciplined unit to enforce the type of rigor

and conditions that the tasks are suggesting. Updating the METL with performance measures forcing the use of analog systems improves readiness and fills the capability gap of maintaining firing capability in a degraded environment in large scale combat operations.

While FM 3-09 states that manual backups serve as just that, a backup, and should not hinder the process and set up of automated means, there is a lack of emphasis placed on training analog means in the CATS METL tasks. Much like TC 3-09.8 dictates the types of fire missions by either automated or manual means, there appears a lack of such focus in the TE&Os upon analyzation. If units are utilizing the TE&Os for conducting collective training and are utilizing them as a performance checklist, then as opposed to the TC 3-09.8, performance tasks are open for interpretation by each unit.

Analysis of the USAFAS

The next leg portion of the analysis is analyzing POIs at the USAFAS to determine what level of detail the USAFAS instructs in analog means of establishing and maintain firing capability. By reviewing the POIs at the USAFAS for FABOLC-B, FACCC, ALC, and SLC, this thesis will show the depth of analog TTPs taught at the institutional level for junior officers and non-commissioned officers if the U.S. Field Artillery.

Analysis of USAFAS POI for 13B, Cannon Crew Member ALC

The Field Artillery Cannon Section Chief ALC's design is to train field artillery cannon section chiefs to lead, train, and direct subordinates to maintain, operate and employ weapons and equipment. The course is broken down into 25 training days

consisting of 301 training hours and develops 13B sergeants to perform the duties of section chief. The course trains 13B NCOs on the skills and knowledge required to certify howitzer sections and prepares NCOs to lead the section providing timely and accurate fires in support of LSCO.[211]

For the 13B Cannon Crewmember ALC, there is a four-hour block of instruction on task 061-DB44LD/6.0, which is, operate a howitzer DFCS during degraded operations. The block of instruction consists of 10 minutes of Small Group discussion, 1.8 hours of demonstration, two hours of practical exercise, and 10 minutes of reflective discussion. The conditions are as a section chief, given in a field environment, a howitzer with a prime mover, an inoperable DFCS, and authorized equipment and section crew. The standard is to operate a howitzer DFCS in degraded operations and maintain firing capability using non-digital systems per the appropriate technical manual. The soldier must operate both the M119A3 and M777A2 Howitzer DFCS in degraded operations without error. Task 061-DB44LD/6.0, operate a howitzer DFCS during degraded operations, is the only task covered at ALC for 13B Cannon Crewmembers regarding non-automated procedures. The ALC for 13Bs encompasses six other tasks regarding the DFCS. Tasks including identifying the DFCS and its components, initialize the DFCS, perform DFCS confidence checks, navigate a howitzer using the DFCS, conduct fire missions using the DFCS, and enter a manual move order using the DFCS. All six tasks regarding the DFCS encompass 23 hours as opposed to the four hours for operating the DFCS during degraded operations. The focus in hours at 13B ALC for degraded

[211] United States Army Field Artillery School (USAFAS), *Course Management Plan 041-13B30-C45,* ver. 6.0 (Fort Sill, OK: Headquarters, USAFAS, August 2018), 3.

operations is approximately 17 percent of the hours focused on automated means for howitzers with an overall percentage of a little over 1 percent for degraded operations throughout the entire course.

Analysis of USAFAS POI for 13J, Cannon Crew Member ALC

The 13J Fire Control Specialist ALC's design is to train the 13J30 MOS in modern battlefield TTPs and to supervise the operation of Field Artillery Battlefield Automated Systems.[212] The ALC for 13J Fire Control Specialists provides instruction in fire support command and control operations, effective communication skills, tactics, leadership, training management, advance concepts of automated fire direction, manual gunnery, and instruction for the NCO to function as a battle staff operator in an AFATDS organization.[213] The course comprises of 6.5 weeks of training with 368 training hours.

The Technical Fire Direction Module contains 110 training hours. Within Module C, the classes cover manual computation of muzzle velocity and cannon safety with requisite exams. Task 061-280-3010 pertains to computing muzzle velocities. The task has 60 minutes for group discussion and 29.5 hours for practical exercises. Tasks 061-280-3003 through 061-280-3006 encompass computing safety for low angle, high angle, illumination, and smoke. There are 71 instruction hours dedicated to the task of computing safety at the 13J Fire Control Specialist ALC. The culminating event is a three-hour test in which students must score at least 80 percent.

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[212] United States Army Field Artillery School (USAFAS), *Course Management Plan 043-13J30-C45,* ver. 1.3 (Fort Sill, OK: Headquarters, USAFAS, October 2018), 1.

[213] Ibid.

Of the 368 training hours for 13J Fire Control Specialist ALC, approximately one-third of the course focuses on manual computational procedures regarding muzzle velocity and safety data. By focusing a more substantial portion of instructor hours as compared with the 13B MOS ALC, there appears to remain the importance of degraded focused training for fire direction personnel still at the schoolhouse and should remain in the POI for future classes.

Analysis of USAFAS POI for 13R, Field Artillery Firefinder Radar Operator ALC

The purpose of 13R ALC is to provide NCOs with operator and maintenance training on the radar system variants.[214] The course has 352 academic hours spanning across approximately ten weeks of training.[215] The scope of training consists of teaching technical and tactical knowledge to support U.S. Army maneuver and field artillery firing units effectively.[216] The course has four training modules, Modules A through D.

Module A, Basic Radar Maintenance, consists of 170 hours of training on basic electronics theory, the Q-36 Radar troubleshooting and alignment, and a radar maintenance exam. Module B, Direct Tactical Employment Techniques, consists of 71 hours. The blocks of instruction for Module B consist of M2A2 Aiming Circle operations, direct tactical employment of a weapon locating radar, radar positioning, and analysis system, determining initialization data and preparing weapon locating radar

[214] United States Army Field Artillery School (USAFAS), *Program of Instruction Course 221-13R30-C45*, ver. 7.1 (Fort Sill, OK: Headquarters, USAFAS, FY 2021), 1.

[215] Ibid., 5.

[216] Ibid., 1.

embedded training. The manual tactics portion consists of eight hours of training on the M2A2 Aiming Circle with a four-hour examination. Module C, Q-53 Radar Troubleshooting, is a 100-hour module with blocks of instruction on managing, maintaining, and troubleshooting the Q-53 Radar, a Q-53 exam, and a radar section leader closed book exam. Module D, Radar Gunnery Tables, is an 18-hour module consisting of blocks of instruction on communicating gunnery requirements for a weapon locating radar section and a gunnery exam.

Of the 352 academic hours dedicated to 13R ALC, there are 12 hours of dedicated training time on analog techniques or approximately 3.4 percent, which focuses on the M2A2 Aiming Circle.

Analysis of USAFAS POI for 13B, Field Artillery Platoon Sergeant SLC

The 13B Cannon Crewmember SLCs design is to train the cannon platoon NCO to perform the duties of the rank Sergeant First Class Platoon Sergeant, Gunnery Sergeant, and Battalion Ammunition NCO and also to assume the duties of the Platoon Leader in their absence.[217] The course consists of 339.8 hours spanning approximately six weeks over 39 training days with three modules. Module A, Technical Training consists of the bulk of the course with 135.2 hours of training. Module A consists of blocks of instruction on the Field Artillery Mission, roles and organization, computing minimum quadrant elevation, M2A2 Aiming Circle employment, security, and Defense Training Management System and CATS training. One highlight is that of the 135.2

[217] United States Army Field Artillery School (USAFAS), *Course Management Plan 041-13B40-C46*, ver. 5.1 (Fort Sill, OK: Headquarters, USAFAS, July 2018), 1.

hours, the 13B SLC dedicates over 39 percent of hours to analog and manual procedures regarding the M2A2 aiming circle. Module B, Survey Training, consists of 71.8 hours on the NIKON NE-102 operations, making survey positions using the IPADS-G system, establishing a declination station, and a survey operations examination. The survey training that the 13B SLC conducts is vital due to the lack of a dedicated Field Artillery Surveyor MOS. The final Module, Module E, consists of a 72-hour situational training exercise.

Upon Analyzing the 13B SLC, there is a higher emphasis on degraded training as opposed to the 13B ALC. The difference is that at the SLC, all of the degraded training is on the M2A2 Aiming Circle. While the researcher believes this is still a vital block of instruction, it does not resolve the issue at the 13B ALC, where a lack of degraded training is evident for the aspect of fire mission processing.

Analysis of USAFAS POI for 13J, Fire Control Specialist SLC

The 13J Fire Control Specialist SLC's design is to train the 13J40 MOS in modern battlefield TTPs and to supervise the operation of Field Artillery Battlefield Automated Systems.[218] The SLC for 13J Fire Control Specialists provides instruction in fire support command and control operations, effective communication skills, tactics, leadership, training management, advance concepts of automated fire direction, manual gunnery, and instruction for the NCO to function as a battle staff operator in an AFATDS

[218] United States Army Field Artillery School (USAFAS), *Course Management Plan 043-13J40-C45,* ver. 1.3 (Fort Sill, OK: Headquarters, USAFAS, October 2018), 1.

organization.[219] The course has four modules, Module A through D, for training with 143.3 hours ranging over four weeks of training.

Module A, Fire Control Operations, consists of blocks of instruction on the roles, missions, and organization of Fires, Digital Standard Operating Procedures, commander's certification program, technical rehearsals, surface danger zones, and firing incident investigations. The surface danger zone portion consists of over 16 hours where students develop an appropriate surface danger zone for a given weapon system, ammunition type, and range medium, which ensures the containment of all rounds and fragments within its boundaries.[220] Students construct the surface danger zones with a Fort Sill map and TFTs for the 155mm and 105mm howitzers. Module B, Plans and Preparations, consists of blocks of instruction of orders and annexes, IPB, and developing the Field Artillery Fire Support Plan with 17 hours of total training. Module C, Automated Fire Control, consists of 32 training hours on system administration, fire support, and an automated fire control examination. The final module, Module D, is a 24-hour situational training exercise where students perform the duties as a Senior Fire Control NCO. The conditions consist of an operational AFATDS with a current database and AFATDS software, tactical operational data, and a completed operations order.[221]

Upon analyzation of the 13J SLC, there are 16 hours dedicated to analog training with the focus in the construction of surface danger zones. The analog training takes up

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[219] USAFAS, *Course Management Plan 043-13J40-C45,* ver. 1.3, 1.

[220] Ibid., 12.

[221] Ibid., 21.

approximately 11 percent of the course, but the focus for the 13J at the battalion level is not in the manual gunnery realm. One issue the researcher observes is that even though a 13J at the battalion level already has the requisite knowledge for manual gunnery pending that 13J completed ALC before the MLRS and cannon fire control specialist merger, the analog TTPs and lack of manual gunnery at the 13J SLC could inhibit an MLRS fire controller who completed 13J ALC after the MOS merger.

Analysis of USAFAS POI for 13R, Field Artillery Radar and Targeting NCO SLC

The 13R SLC is a 10.5-week course with 369.4 hours of training divided into four modules. The course provides senior NCOs with the knowledge to operate and maintain the radar systems and the duties for target acquisition platoon sergeant, section leader, and senior counterfire NCO.[222]

Module A, Senior Radar, and Counterfire NCO consists of 96 training hours ranging from duties and responsibilities, radar deployment order production, Brigade Tactical Operations Center and Fire Support Element structure, sensor management, IPB, and Fire Support Coordination Measures. Module B, Survey Operations consists of 120 hours with blocks of instruction on NIKON NE-102 operations, marking survey positions with the IPADS-G, establishing declination stations, survey operations planning, and a six-hour exam. The 13R SLC teaches survey operations to help bridge the gap of a lack of a Field Artillery Surveyor MOS. Module C, Joint Conflict and Tactical Simulation Situation Training Exercise consist of 153.4 hours with blocks of instruction on fire

[222] United States Army Field Artillery School (USAFAS), *Program of Instruction 221-13R40-C46,* ver. 6.1 (Fort Sill, OK: Headquarters, USAFAS, FY 2021), 1.

support plans, AFATDS operations relevant to radar supervisors, a 72-hour situational training exercise, and a four-hour radar operations exam. Module D, Radar Gunnery Tables, consists of 20 hours of training time with two blocks of instruction in gunnery requirements for a senior 13R NCO and developing standard operating procedures.

The 120-hour, or approximately one-third of the course, block of instruction on survey operations at the 13R SLC is an attempt to meet the capability gap of a dedicated surveyor for the field artillery. When comparing the 13R ALC and SLC, the research shows a higher emphasis on degraded techniques at the SLC, specifically regarding survey operations. The NIKON NE-102 is another surveying instrument for measuring angles, much like the M2A2 Aiming Circle, with the lack of metal interference issues. The focus of degraded survey operations at the 13R SLC comprises of 104 training hours with a 16-hour exam. The added hours are demonstrative of the necessary TTPs required for emplacing survey in a D3SOE that U.S. Field Artillery units are prone to see in LSCO.

Analysis of USAFAS POI for the USAFAS Field Artillery Basic Officer Leader-Branch Course

The FABOLC-B provides newly commissioned lieutenants with general knowledge of the Field Artillery and specific skills and in-depth knowledge in the areas of fire support, observed fire, fire direction, tactical communications, leadership, and platoon operations.[223] The course contains 11 modules of training, with ten modules

[223] United States Army Field Artillery School (USAFAS), *Course Map FABOLC-B Course 2-6-C20B, Resident,* ver. 6.0 (Fort Sill, OK: Headquarters, USAFAS, January 2019), 3.

geared explicitly towards the Field Artillery branch, and one module, Module A, on a common core curriculum. The FABOLC-B is 798.5 academic hours, with 693 hours dedicated to the Field Artillery branch and 105.5 hours allocated towards the common core. Module A, Common Core, contains a plethora of blocks of instruction such as military history, property accountability, small unit operations, and basic rifle marksmanship. Modules B through E pertains to manual gunnery relating to fire direction. Modules, F, G, and H pertain to fire support foundations, and planning. Module J entails IPB, combined arms defense, targeting, and offensive operations. Module K is a 49-hour block of instruction on basic platoon leader training, and Module L is a capstone field training exercise, Red Leg War.

The four gunnery modules comprise of 270 hours covering all aspects of manual and automated fire direction. Some blocks of instruction are firing charts, firing tables, safety, muzzle velocity management, and AFATDS mission processing. The instruction hours specifically relating to manual gunnery are approximately 152. The 152 hours account for all training and exams relating to manual gunnery, and the hours also include instruction hours relating to special munitions and surface danger zones.

The three fire support modules comprise of 233 hours of fire support foundations and fire support planning. The blocks of instruction cover instruction hours on tasks such as call-for-fire, joint fire support planning and execution, terminal attack control, guided munitions employment, and offensive and defensive fires planning.

Module J, Combined Arms Delivery, is a 29-hour module. The Combined Arms Deliver module consists of IPB, targeting methodology, combined arms defensive

operations, combined arms offensive operations, and operations order briefs and practical exercises.

The Platoon Leader module, Module K, is a 49-hour module. Module K consists of blocks of instruction on aiming circle operations, maintenance operations, communications, MLRS employment, and platoon certification. The aiming circle block of instruction is an 8-hour block on the manual techniques required M2A2 Aiming Circle operations.

The final module, Module L, is a 112-hour field training exercise more commonly referred to as the Red Leg War. The Red Leg War is the culminating event for FABOLC-B, where students conduct all portions of instruction learned at the FABOLC-B from fire support, fire direction, and platoon leader operations.

Excluding the 105.5-hour common core module, the FABOLC-B consists of 693 hours focusing on the Field Artillery branch. Based on the course curriculum and excluding the 112-hour Red Leg War, students at the FABOLC-B spend approximately 160 hours, or around 28 percent of course hours learning manual gunnery and aiming circle operations. The data also does not take into account any portions of the Red Leg War, where students also perform manual and degraded operations.

Analysis of USAFAS POI for the USAFAS Field Artillery Captains Course

The FACCC develops field artillery officers into having confidence in leading soldiers and competent in providing fires in support of the maneuver commander in

ULO.[224] The course contains 869 academic hours and consists of four modules, Modules A through D.

Module A, Common Core, is a 320-hour block of instruction containing 51 different classes. Some of the classes in the Common Core Module are critical and creative thinking, effective writing, military justice for leaders, commander's programs, framing the operational environment, and tactical logistics. Module B is a 16-hour staff ride to the Battle of Washita, approximately two hours northwest of Fort Sill.

Module C, Gunnery, is a 139-hour module where Field Artillery Officers review courses from the FABOLC-B. Courses include firing tables, muzzle velocity management, safety, and AFATDS operations. The Gunnery Module at FACCC is about half the hours, or 139 hours, as opposed to the 270-hour module at the FABOLC-B. Including practical exercises for safety, firing tables, site, and troubleshooting, the FACCC allocates 32 of the 139 hours during the Gunnery Module to manual and degraded techniques or approximately 23 percent of the entire module and 3 percent of the entire course. The bulk of the Gunnery Module is on AFATDS operations such as communications, battalion fire mission processing, and database construction.

The final module, Module D, is a 394-hour module on Field Artillery Technical and Tactical Operations. Blocks of instruction cover joint fires observation, targeting, fire support planning, the military decision-making process, and field artillery battalion command post operations. Module D is the majority of the FACCC covering almost half of the entire course.

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[224] United States Army Field Artillery School (USAFAS), *Program of Instruction FACCC Course 02-6-C22,* ver. 3.0 (Fort Sill, OK: Headquarters, USAFAS, FY 2018), 1.

Of the 869 hours that the FACCC encompasses, there are approximately 32 hours or around 3 percent of the course dedicated to manual and degraded techniques. The 32 hours of manual gunnery taught at the FACCC is more of a recap of what Field Artillery Officers learn at the FABOLC-B, and less instruction at the FACCC seems relevant.

Analysis of Trends, Data, and Personal Observations of the JRTC Rotations for FY2019

The JRTC trains IBCTs with a Decisive Action Training Event monthly. The researcher started as a Battalion Fires Cell OCT in June 2017 and became the Senior Fires Live Fire OCT in June of 2018 until June of 2019. As the Senior Fires Live Fire OCT, the researcher was responsible for all aspects of employment, coordination, and safety of artillery, mortars, and rotary and fixed-wing fires. The analysis will encompass personal observations and trends from the year the researcher spent at the Live Fire Division substantiated with data and trends from the Fire Support Division. The analysis will not cover specific units as to keep the anonymity of units but, more so, identify historical data, trends, and issues that U.S. Field Artillery units experience while conducting a Decisive Action Rotation at the JRTC. Some of the critical trends relate to equipment, proficiency, and identification of a D3SOE.

Overall, about 20 percent of units were proficient in degraded operations. Proficiency for purposes of this analysis means that the units were not only capable of performing in a D3SOE but made the transition of establishing and maintaining firing capability from automated to manual procedures. Procedures to include manual fire direction and performing fires delivery without the need for a digital system on the howitzer. Approximately 30 percent of units were capable but lacked proficiency.

Capable for purposes of this analysis means that the units did bring manual equipment such as M2A2 Aiming Circles, TFTs, GFTs, and firing charts. The trend that the researcher saw for this 30 percent of units was that the units had the equipment required for maintaining firing capability in a D3SOE, but lacked the proficiency levels needed without the aid from an OCT. Unfortunately, it was at the observation of the researcher that the other 50 percent of units were lacking not only the capability but also the proficiency required for maintaining firing capability in a D3SOE. Of this 50 percent of units, most did not have full sets of manual gunnery FDC equipment, and some units did not even bring any of the manual gunnery equipment from their home station. Some of the reasoning, when questioned, was either the units did not feel they would need to perform such manual artillery TTPs or some units did not have a comfortable proficiency level and therefore did not even bother packing manual artillery equipment.

One trend the researcher observed was a lack of confidence in providing fires without the use of automated means. One instance, while conducting an initial visit with battery leadership at a firing point, the battery leadership indicated that one howitzer was non-mission capable due to a cable missing for the DFCS. When asked if that was the only issue with the howitzer, the battery leadership replied that this was, in fact, the only issue with the howitzer. Upon further understanding of the situation, the RTU leadership felt uncomfortable with utilizing that howitzer section for live-fire operations, but after coaching from the OCTs that howitzer section did participate in live-fire operations but only after multiple classes and training with the OCTs. Some firing batteries were adamant about refusing a howitzer section that was not mission capable regarding digital systems to conduct live-fire operations. The reasoning of battery leadership typically

pertained to risk, safety, or a lack of confidence. Despite having OCTs readily available for assistance, units often only participated in live-fire exercises with only digitally capable howitzer sections, thus having typically only four or five howitzer sections instead of the full accompaniment of six howitzer batteries. Battery Commanders did not often see this as an issue, but if all three batteries have the same mentality, then instead of a BCT commander having 18 howitzers capable of providing fires, the BCT commander now only has two batteries instead of three.

Another trend the researcher observed was a failure to identify the requirement to shift from occupying a firing point without automated means. One instance, the researcher observed a firing battery delaying occupation for approximately 30 minutes because the unit was having issues with all of the GPS functions on the howitzers. The unit failed to transition to occupying with degraded procedures. It thus led to a delay in providing fires for brigade operations due to constant troubleshooting of the digital systems as opposed to establish firing capability first and attempt to troubleshoot digital issues at a later point in time. The JRTC does a phenomenal job of replicating a D3SOE, and upon analysis of the Fire Support Division AARs, RTU detects GPS denial operations approximately 31 percent of the time. Of that 31 percent detection rate, RTU submits a Joint Spectrum Interference Report, for approximately 24 percent of all detections, but that equates to RTU generating a report for only 7 percent of all detections. Therefore, RTU is identifying denial operations one-third of the time, and only seven times out of 100 is RTU generating a report notifying higher headquarters elements.

The researcher's observations of rotations at the JRTC for FY2019 highlight several issues of establishing and maintain firing capability in a D3SOE. The first issue is that approximately 80 percent of units that come to the JRTC lack the equipment necessary for operating in a D3SOE, or units have the equipment required for maintaining firing capability in a D3SOE but lack the competency of providing fires with manual equipment. The second issue the researcher observed is a lack of confidence in providing fires without the use of automated means. All too often, unit leadership lacked the confidence and erred on the side of safety and did not allow howitzer sections that were not fully automated to participate in live-fire exercises. By doing so, BCT commanders lack the full accompaniment of fires available during live-fire operations. The final trend is a lack of identifying a D3SOE. The opposing forces and OCTs possess the capability of denying, disrupting, or degrading GPS functions. By doing so, RTU fails to identify the D3SOE and spends more time troubleshooting vice transitioning to non-automated procedures, which leads to a delay in providing or maintaining firing capability in a D3SOE. In terms of LSCO, U.S. Field Artillery units will lack the comfort of performing operations in a non-contested environment and must possess the capability of providing fires by all means possible.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

The purpose of the research is to identify what current U.S. Field Artillery doctrine, training, and leadership/education domains articulate for operating within a D3SOE. The research analyzed a vast array of doctrinal publications to identify what doctrine is readily available for U.S. Field Artillery leaders to reference regarding degraded operations. The research analyzed the ATN regarding the CATS and METL tasks for U.S. Cannon Artillery units to establish whether or not any tasks require performing under degraded conditions. The research analyzed the POIs for the USAFAS for NCO and officer courses to identify how much non-automated training the USAFAS conducts at ALC, SLC, FABOLC-B, and FACCC. Finally, the research includes personal observations of the researcher of trends on FY2019 rotations at the JRTC. The research includes observations of RTU regarding operating in a D3SOE with data and AARs from the Fire Support Division at JRTC. Chapter 5 chapter identifies key sustains and shortfalls that the research identifies for the doctrine, training, and leadership/education domains and recommendations for units to conduct regarding establishing and maintain firing capability in a D3SOE. Last, the conclusions chapter provides recommendations for further study based on the research identified in this thesis.

Doctrinal Domain Conclusions

The most significant doctrinal analysis lies in the new draft of FM 3-09, Fire Support and Field Artillery Operations dated 27 August 2019. The new FM 3-09 dedicates an entire appendix on denied, disrupted, and degraded conditions. The appendix

discusses the types of denied, disrupted, and degraded operations and training for these types of conditions. The appendix also discusses the five requirements for accurate predicted fire during such conditions. The draft version of FM 3-09 serves as an example of how important it is to senior leaders that U.S. Field Artillery units must establish and maintain firing capability in a D3SOE. On the first page of the appendix on degraded operations, doctrine writers highlight that enemies and adversaries will seek to contest the operational environment to limit the U.S. and multinational forces' capabilities. By mentioning the aspect early in the appendix, it demonstrates the more significant problem at hand and how U.S. Field Artillery units will not have the luxury of operating in a non-contested environment, and that the skills that artillerymen need include both automated and non-automated facets within the Fires WfF. The draft version of FM 3-09 demonstrates that senior field artillery leaders are aware of the lacking detail in doctrine regarding operating in a D3SOE and are remedying such shortfalls. With the addition of an entire appendix focusing artillerymen on how a D3SOE will affect the future fight in LSCO, and the repetitive mentioning of adversaries' capabilities and threats, provides readers as to why training on analog and degraded TTPs is a top priority for senior artillerymen.

The FM 3-09, Field Artillery Operations and Fire Support, dated April 2014, is an excellent source for planning operations in support of ULO. The publication provides planning considerations for fire supporters at all levels of incorporating fires plans to support maneuver commanders. FM 3-09, dated April 2014, does not provide planning factors when operating in a D3SOE. FM 3-09 also lacks for how fire supporters and U.S.

Field Artillery units can capitalize and ensure that establishing and maintaining fires during planning, preparing, executing, and assessing.

The second most significant doctrinal analysis is the ATP 3-09.02, Field Artillery Survey. Similarly, to the draft FM 3-09, ATP 3-09.02 highlights how the current operational environment and peer threats require field artillery community to conduct GPS denied and systems degraded operations. Chapter 7 of ATP 3-09.02, in the opinion of the researcher, is the most astounding. Chapter 7 articulates the types of survey methods available to U.S. Field Artillery units in all operating environments. Chapter 7 mentions priority means of providing survey control with the IPADS and IPADS-G, Nikon NE-102 Theodolite, NAVSTAR GPS, Handheld Terminal Units, and Astronomic Observation. Astronomic Observations provide surveyors with the ability to check azimuths, provide orienting azimuths for cannons and fire control equipment, determine azimuths for declinating aiming circles, and provide orienting azimuths for radar and observation posts. Chapter 7 provides Field Artillery Surveyors with the means of providing survey control by utilizing the sun, moon, or other stars in which adversaries cannot disrupt, deny, or degrade. Since the M2A2 Aiming Circle relies only on the magnetic force of the earth, by utilizing Astronomic Observation techniques, field artillery surveyors can provide survey control in a D3SOE.

The ATP 3-09.50, The Field Artillery Cannon Battery, and ATP 3-02.23, Field Artillery Cannon Battalion, provide fire supporters a reference for applications regarding degraded operations and planning factors. In both publications, the emphasis is on FDC TTPs. The Field Artillery Cannon Battalion Publication addresses tactical and technical fire direction duties and responsibilities in a degraded capacity and also internal

networking at the battalion level during degraded operations. Whereas, The Field Artillery Cannon Battery publication only mentions tactical and technical duties and responsibilities in a degraded capacity. Both publications focus on FDC direct control of technical fire direction but lack TTPs for cannon battery and battalions operating in a degraded operating environment.

ADP 3-19, Fires, dated July 2019, provides a broad overview of possible planning factors and considerations for operating in a D3SOE. ADP 3-19 does acknowledge preparing to operate in a contested environment from friendly and enemy capabilities, specifically when discussing precision munitions vice conventional munitions. The preface of ADP 3-19 acknowledges that the publication is a broad conceptual basis for the Fires WfF lacks addressing possible issues when operating in a D3SOE.

TC 3-09.8, Fire Support and Field Artillery Certification and Qualification, acknowledges and defines denied, disrupted, and degraded conditions. Artillery Tables IV through VI are individual howitzer section tables where Artillery Table VI is a howitzer section live-fire qualification. The TC 3-09.8 articulates for howitzer sections in which fire mission's performance is with FOC, degraded, or manually. The issue is that the preponderance of fire missions are with FOC except for a low angle adjust fire mission, coordinated illumination, out of sector fire mission, and a sweep and zone fire mission. The reasoning for a sweep and zone mission performance being manual is due to the complexity of computing multiple deflections and quadrant elevations that a sweep and zone fire mission requires. The reasoning for a coordinated illumination mission performance being a degraded mission is also because of the complexity of computing multiple fire missions simultaneously. Units will compute two separate fire missions in

the AFATDS and then send the fire missions as adjust fire missions digitally to the guns. One mission is the illumination portion, and the other mission is a regular high explosive fire mission. Fire Direction personnel make the height of burst corrections for the illumination portion and apply the corrections to the AFATDS and send the adjustments digitally to the howitzers. The mission's performance is with voice commands to ensure howitzers fire at the correct intervals to achieve the effects so that observers can observe the desired effects of high explosives simultaneously with illumination. The low angle adjust fire mission, and the out of sector fire missions are the outliers. These fire missions can perform either with FOC, degraded, and manually. The TC 3-09.8 dictates that only two of 18 fire missions perform degraded or manually. For Collective Artillery Tables for the platoon, battery, and battalion, the specificity of either FOC, degraded, or manual lies with the certifying commander. The issue is the lack of standardization across U.S. Field Artillery units, and in theory, according to the doctrine, certifying commanders can deem that all fire mission's performance is digital. TC 3-09.8 establishes tasks and fire missions for all Artillery Tables and provide a level of specificity for whether the performance is digitally or not.

Doctrinal Domain Recommendations

The most significant recommendation regarding the doctrinal analysis is with the TC 3-09.8, Fire Support and Field Artillery Certification and Qualification. It is the opinion of the researcher of too much ambiguity regarding conducting Artillery Tables in a degraded capacity. Only two fire missions for individual howitzer sections performance is either degraded or manual, with the remainder being in a FOC mode for Artillery Tables IV through VI. The recommendation is for more fire missions for the TC 3-09.8 to

mandate more fire mission's performance in a capacity other than with FOC. For example, since Artillery Tables IV and V do not require live munitions, then perhaps conducting all fire missions with FOC and either degraded or manual, time permitting. Since Artillery Table VI requires live munitions, perhaps perform four of the eight fire missions either manually or degraded. For the platoon, battery, and battalion collective training tables, it is the opinion of the researcher to perhaps perform at least one occupation and all fire missions at a given firing point under D3SOE conditions. That way, platoons, and batteries are getting at least one repetition of occupation and multiple fire missions upon occupation performing without FOC. Survey and Radar sections can benefit as well from operating under the same D3SOE condition for a Collective Artillery Table XVIII: Battalion Live Fire Qualification. Otherwise, with the way TC 3-09.8 reads now, the level of degraded or manual tasks lies with certifying commanders, thus creating a lack of standardization across U.S. Field Artillery formations.

Training Domain Conclusions

Analysis of the ATN provides context similar to the TC 3-09.8 regarding clarification and direction for training task U.S. Field Artillery units must perform without digital capability. The research of the ATN consisted of four tasks U.S. Field Artillery cannon units perform, ranging from occupying tactical areas, conducting towed artillery occupations, processing fire missions, and conducting howitzer fire missions. Similarly, to the TC 3-09.8, the tasks in the ATN after researching proved too ambiguous regarding directing task performance under D3SOE conditions.

Regarding the first and second tasks 06-BTRY-3001, Occupy a Tactical Area, 06-BTRY-3026, Conduct a Towed Artillery Occupation, conditions for the task recommend

that some tasks should be conducted in a degraded or GPS denied environment. By suggesting such conditions as opposed to mandating, this leaves the conditions open for interpretation by different units, thus leading to a lack of standardization like the research with TC 3-09.8.

The third task, 06-BTRY-5424, Process Fire Missions, the research includes two supporting tasks. The two supporting tasks of 061-13B-3001, Initialize the DFCS, and 061-300-1010, Prepare Fire Mission Processing Data in an AFATDS. The research of the tasks above mentions no performance of fire missions on both the howitzer and FDC with non-digital means. Again, all conditions suggesting operating under degraded conditions lies solely with appropriate commanders conducting the training.

The final task within the research is Task 06-SEC-5017, Conduct Howitzer Fire Missions. Seven subtasks under the collective task mention operating and processing fire missions with the GDU and GDU-R, which is a digital system within each howitzer section. There lacks prominence on mandating the performance of the task under D3SOE conditions, much like all tasks in the research.

The common theme while researching the ATN for U.S. Field Artillery Cannon units is the word “should” under conditions for the tasks. However, some multiple tasks and subtasks mandate utilizing a digital piece of equipment typically with the howitzer sections. The interpretation of such verbiage remains open for all units utilizing the ATN when referencing METL tasks.

Training Domain Recommendations

It is not the intent of the research to demonstrate that certifying commanders are not heeding the suggestions in the METL. Observations of the researcher while at the

JRTC demonstrates that some units are, in fact, proficient at establishing and maintaining firing capability in a D3SOE. Unfortunately, that was approximately 20 percent of units for the FY2019. The research is merely highlighting the adage that "words mean things." Much like the TC 3-09.8, the conditions that the METL suggests for U.S. Field Artillery cannon units to perform tasks under degraded conditions. By mandating a quantifiable number of tasks, time under degraded conditions, or similar measurable conditions, units referencing the ATN provided METL tasks now have a benchmark to aim for while conducting METL tasks. Another recommendation is at a minimum performing an Artillery Table V and VI, Section Certification and Qualification, with one complete iteration in a digital capacity and another entire iteration in a degraded capacity. For the Collective Artillery Tables XII and XV, Platoon and Battery Qualification, at a minimum performing at least one entire occupation of a firing point to include fire mission processing entirely in a degraded capacity.

Leadership/Education Domain Conclusions

The analysis of the leadership/education domain includes ALC and SLC for the 13B, 13J, and 13R MOS', FABOLC-B, and FACCC POIs from the USAFAS. The analysis focuses on a quantifiable number of hours relating to manual and non-automated procedures.

For the 13B ALC at the USAFAS, approximately 1 percent of hours throughout the POI focus on degraded operations, specifically with howitzer fire missions. That equates to 17 percent of how much training the 13B ALC conducts training utilizing the DFCS for processing fire missions. Twenty-three hours dedicate training to tasks regarding the DFCS, only four hours of training focus on operating the DFCS during

degraded conditions. For the 13J ALC at the USAFAS, approximately one-third of the course training is on manual computational procedures. The emphasis that the 13J ALC places on manual gunnery is inherent with the tasks that FDCs will conduct at the platoon level. There is a stark contrast between the focus of hours on manual procedures between the 13B and 13J ALC. For the 13R ALC, approximately 3.4 percent of the training hours focus on non-automated procedures. The focus of analog training at the 13R ALC is specific to training on the M2A2 Aiming Circle.

While researching the POI for the 13B SLC, there is a higher weight of training hours that the course provides for training on degraded procedures. Excluding the 72-hour field training exercise and administrative hours, the 13B SLC training on manual procedures makes up approximately 21 percent of the POI. There are also 71.8 hours that the 13B SLC dedicates to survey operations with the NIKON NE-102 and IPADS-G systems for providing survey control. The focus in training hours is drastically different from the 13B ALC regarding degraded operations. Meanwhile, at the 13J SLC, only 16 hours, or approximately 11 percent of the course, focus on manual computational procedures for fire direction and fire control. Earlier, the analysis was demonstrative of higher stress of manual training at the 13J ALC, and the issue is with the MLRS and Cannon Fire Direction MOS' merger. If a former MLRS Fire Control NCO attended the respective ALC before the merger, cannon battalions could potentially have a battalion fire control NCO who has never had to perform manual gunnery. Therefore, when platoon FDCs have issues with manual gunnery procedures, the battalion fire control NCO, at no fault of their own, lacks the knowledge in rectifying issues. The researcher saw this exact situation while working at the JRTC. For the 13R SLC, the most

groundbreaking data point is the 120 hours of instruction on survey operations. The added hours, coupled with the blocks of instruction on survey operations at the 13B SLC, attempt bridge the capability gap of a lack of the Field Artillery Surveyor MOS no longer on the MTOE. The training hours on survey operations at the 13R SLC comprises of 120 hours or approximately 32 percent of the POI. The additional hours of training on survey operations are demonstrative of the effort the USAFAS is trying to rectify regarding the capability gap in lacking the Field Artillery Surveyor MOS. The issue lies in the way the U.S. Army utilizes the Select, Train, Educate, and Promote system. If a Battalion Radar Platoon Sergeant is not a Sergeant First Class, then he or she lacks the required knowledge on establishing common survey across all firing elements within the formation.

The FABOLC-B comprises of 693 hours focusing on the Field Artillery branch. Excluding the 112-hour field training exercise, the Red Leg War, FABOLC-B officers spend 160 hours, or approximately 28 percent of course hours training on manual gunnery and aiming circle operations. It is the opinion of the researcher that the higher emphasis of manual gunnery training hours is because most FABOLC-B officers upon graduation will likely become FDOs early in their career. Basing the observations of the researcher having spent approximately 11 years in the Field Artillery, most new lieutenants become FDOs of FSOs as the first position upon graduating FABOLC-B. The high concentration of training spent on manual gunnery at the FABOLC-B further enables lieutenants who become FDOs to aid and enable FDCs to establish and maintain firing capability in a D3SOE. At the FACCC, officers spend 32 hours or 23 percent of the entire Gunnery Module at the FACCC on manual gunnery procedures. It is the opinion of

the researcher that the lack of emphasis on training hours at the FACCC as opposed to the FABOLC-B, is due to the training at the FACCC on manual gunnery is simply a review of what the officers learned approximately, two to four years upon graduating the FABOLC-B. The review on manual gunnery helps enable young captains to facilitate manual safety and manual gunnery at the battalion level for subordinate FDCs as well as battery commander's enough knowledge to help manage the five requirements for accurate and predicted fire at the platoon and battery level. While serving as a battery commander, during field training exercises, the researcher spent the preponderance of time within the Battery Operations Center and subordinate FDCs to help young FDOs. The luxury that the researcher has is that the researcher was a Platoon and Battalion FDO and also learned manual gunnery at the FABOLC and FACCC.

Leadership/Education Domain Recommendations

It is the opinion of the researcher to add more training hours at the 13B ALC, focusing on processing fire missions at the howitzer section level in degraded conditions. There simply lacks a foundational knowledge at the 13B ALC and observations of the researcher while at the JRTC support this recommendation. The research also recommends adding more survey operations at the 13R ALC. This recommendation derives from the observation that the majority of Battalion Radar Platoon Sergeants are senior staff sergeants who have not conducted SLC yet. Since providing a survey now falls under the 13R MOS, it is beneficial for 13R's to learn more survey operations at the ALC as well as SLC. The research also demonstrates the recommendation of adding manual gunnery training at the 13J SLC until all legacy MLRS Fire Direction NCOs have the requisite knowledge of computing and troubleshooting manual gunnery procedures.

The researcher recommends sustaining the manual gunnery blocks of instruction at the 13J ALC since there is a lack of manual gunnery training at the 13J SLC, in time, the 13J MOS can sustain the required skill set at the staff sergeant level, that by the time the same NCOs are at the battalion level, they have the manual gunnery procedures needed to help subordinate FDCs. The research also recommends retaining the M2A2 Aiming Circle at the 13B SLC to help with establishing positioning at the platoon and battery level. Also, the research recommends sustaining the survey operations blocks of instruction at both the 13B and 13R SLC to aid in bridging the capability gap of a lack of the Field Artillery Surveyor MOS. While the 13B SLC trains NCOs on being a platoon sergeant, upon completion of platoon sergeant duties, some NCOs will go to battalion to take on the role of the battalion master gunner or other operations cell NCOs. At the battalion level, senior 13B NCO, or more commonly referred to as the Battalion Master Gunner, can aid 13Rs in providing survey control for the entire battalion. It is the recommendation of the researcher to establish the Master Gunner as the primary source for establishing common survey for firing elements and the Radar Platoon as an alternate. The research and observations of the researcher also suggest sustaining manual gunnery at the FABOLC-B and FACCC. The added emphasis of manual gunnery training at the FABOLC-B is respective to the amount of manual gunnery young platoon FDOs will do as platoon FDOs. The review on manual gunnery at the FACCC provides enough training hours to help aid captains the necessary knowledge required while serving as a battalion FDO and also as a battery commander to provide input and troubleshooting the platoon FDOs.

Recommendations for Further Study

If someone were to pick up where the researcher left off, the researcher recommends multiple courses of action. The original intent of this thesis was to explore all domains of the DOTMLPF-P framework to identify gaps in U.S. Field Artillery units operating in a D3SOE. Upon further review, the limiting factor in meeting the intent was a page length constraint. The researcher recommends exploring the organizational, material, and personnel domains of the DOTMLPF-P framework.

Future researchers can explore the organization domain to confirm or deny if the organization of U.S. Field Artillery allows units to fight appropriately in a degraded environment by analyzing unit MTOEs. By scrutinizing equipment by national stock number and quantity, and personnel by MOS, quantity, and rank, future researchers can explore the organization domain in detail to help answer the question: Does U.S. Field Artillery units have the requisite MTOE to operate in a D3SOE and LSCO successfully. Also, within the organization domain, future researchers can discover current unit on-hand quantity by line number aligned with the MTOE to see if even if units have the on-hand quantity identified in the MTOE, and if that is still enough for U.S. Field Artillery units to operate successfully in a D3SOE.

Additionally, future research in the material domain is beneficial due to the vast new programs that the FCoE is developing as part of the Long-Range Precision Fires initiative from former Chief of Staff of the Army, General Mark Milley. Since the Long-Range Precision Fires initiative is so important to senior leaders in the army, future researchers can look at the implications, capabilities, and possible shortfalls that can result in the fires community with Long-Range Precision Fires operating in a D3SOE.

Other possible future research is specifically with developing new material solutions that U.S. Field Artillery units require when operating in a D3SOE. Future researchers could spend an entire thesis researching capability gaps and future mitigation procedures needed for the fires community to deliver fires during LSCO successfully.

The last domain the researcher recommends for future research is the personnel domain. Future research in the personnel domain can help answer the question: Do the U.S. Field Artillery have the availability of qualified personnel for peacetime, wartime, and contingency operations? The research in the personnel domain goes hand-in-hand with the organization domain and can help identify possible shortfalls specifically regarding personnel within the U.S. Field Artillery community.

Other possible recommendations for future research regarding the domains the researcher identifies in this thesis pertains to the leadership/education domains. The researcher did not provide any analysis on what soldiers learn at MOS respective Advanced Individual Training. Future researchers can expand on the leadership/education domain by conducting a thorough analysis of all Advanced Individual Training within the Field Artillery Branch.

Another recommendation for future research is concerning the training tasks and Artillery Tables for fire support personnel and also the respective ALC and SLC for the 13F MOS. Future researchers can expand upon this thesis by conducting a thorough analysis of the Fire Support Training METL Tasks, the associated chapter in the TC 3-09.8 for fire support training, and the USAFAS ALC and SLC for the 13F MOS to further help clarify the research questions in this thesis.

The last recommendation the researcher provides for future researchers is by looking at all the same domains within this thesis, but focusing all efforts on MLRS units. The researcher provides analysis on U.S. Field Artillery Cannon units but purposefully excluded the MLRS community. The researcher excludes MLRS units only because of a lack of experience with MLRS, but a future researcher with a background in the rocket and missile community can efficiently address the same domains as this thesis and apply it to MLRS units.

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