

ARMOR/ANTIARMOR OPERATIONS IN
SOUTH-WEST ASIA

BATTLEFIELD ASSESSMENT TEAM
ARMOR/ANTIARMOR TEAM

[USMC-REPORT]

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DRAFT

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BIOGRAPHY

There were four members of the Armor/AntiArmor effort, three of whom were recruited while deployed to South-West Asia and detached upon return to the United States.

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Major Kelly is an infantry officer (0302) who has graduated from The Basic School, the United States Army's Advanced Infantry Officer Course and the Marine Corps' Command and Staff College. During his career he has commanded two infantry and one weapons companies, and has served as an operations officer in an infantry battalion. In his last tour he was first the Head of the Offensive Tactics Section, then for 29 months the Officer in Charge of The Infantry Officer Course, The Basic School, Quantico, Virginia. Major Kelly is currently attending the School of Advanced Warfighting, Quantico, Virginia.

Captain Douglas Seal USMC

Captain Seal is an armor officer (1802) who has graduated from The Basic School, and The United States Army's Armor Officer Basic Course. He served with the 3d Tank Battalion, 7th Marine Expeditionary Brigade as a tank and TOW platoon commander. When deployed to South-West Asia as a volunteer he served as a company commander of a combat replacement company. Captain Seal is currently serving as a company commander with the Recruit Training Regiment, San Diego, California.

First Lieutenant (Capt. Select) William B. Harrison USMC

Lieutenant Harrison is an armor officer (1802) who graduated from The Basic School and the United States Army's Armor Officer Basic Course. He served with the 3d Tank Battalion, 7th Marine Expeditionary Brigade, as both platoon commander and company executive officer. He also served as a training officer of a combat replacement company when initially deployed to Saudi Arabia. Lieutenant Harrison is currently a tactics instructor at The Basic School, Quantico, Virginia.

First Lieutenant (Capt. Select) Robert Esposito USMCR

Lieutenant Esposito is an assault amphibian officer (1803) who graduated from The Basic School and the Assault Amphibian Vehicle Officer Course. He served with the 2d Assault Amphibian Vehicle Battalion as both platoon commander and company executive officer. He also served as a company executive officer of a combat replacement company when initially deployed to Saudi Arabia. Lieutenant Esposito is currently serving with Recruit Training Regiment, Parris Island, South Carolina.

TABLE OF CONTENTS

Acknowledgements.....	ii
Biography.....	iii
Table of Contents.....	iv
Executive Summary.....	xxx
INTRODUCTION.....	xxx
Methodology	
External Sources.....	xxx
KUWAIT THEATER OF OPERATIONS (KTO).....	xxx
Military Aspects.....	xxx
Iraqi Defenses.....	xxx
KTO AND THE EXPEDITIONARY ENVIRONMENT.....	xxx
The Expeditionary Environment Defined.....	xxx
Expeditionary Characteristics of the KTO.....	xxx
IRAQI EQUIPMENT.....	xxx
Sources and Numbers.....	xxx
IRAQ'S MILITARY PERFORMANCE.....	xxx
I MARINE EXPEDITIONARY FORCE (MEF) TRAINING.....	xxx
TARGET ACQUISITION.....	xxx
Location and Identification Friend-or-Foe.....	xxx
Detection Studies and Analyses.....	xxx
GROUND OPERATIONS.....	xxx
MEF Armor and Mechanized Assets.....	xxx
Antiarmor Missiles and Rockets.....	xxx
Direct Fire Engagements.....	xxx
Target Evaluation.....	xxx
AIR OPERATIONS.....	xxx
The Joint Offensive.....	xxx
Shaping the Battlefield.....	xxx
Forward Air Controller(FAC)-Airborne and Attack Profiles...xxx	
Aviation Combat Element.....	xxx
FRATRICIDE.....	xxx
MEF Incidents.....	xxx
Aircrew Concerns.....	xxx
COMMAND, CONTROL AND COMMUNICATIONS.....	xxx
NUCLEAR, BIOLOGICAL AND CHEMICAL.....	xxx
COMBAT SERVICE SUPPORT.....	xxx
RESERVES.....	xxx
DOCTRINE AND TACTICS.....	xxx

SUMMARY/RECOMMENDATIONS.....xxx

Notes.....xxx

Glossary.....xxx

References.....xxx

Appendix. Direct Fire Engagement Statistics.....xxx

EXECUTIVE SUMMARY

This study is an examination of the armor/antiarmor aspects of the Marine Expeditionary Force's (MEF) experiences in Desert Shield and Desert Storm. The paper looks at all elements of the topic, but primarily concentrates on the special characteristics of the theater, the ground engagements, and finally the application of air power in the antiarmor role. Other relevant, but much less developed themes, are combat support and service support, command and control, reserves, fratricide, nuclear, biological and chemical warfare, and doctrine and tactics. It concludes that the allied success against Iraqi armor was more a function of the extremely poor quality of the Iraqi soldier and the particulars of the theater, than it was to any training and/or equipment advantage the allies might have enjoyed.

The paper examines the Kuwait Theater of Operations and emphatically states that it represents an extreme in terms of its physical and tactical characteristics, when compared with the rest of the globe. The effects of our weapons and equipment were maximized with little or no advantage going to the Iraqi. He was out-gunned in every system and category, and his foolish choice of defensive orientation played to the strengths of U.S. capabilities.

On the ground, the MEF, and for that matter all other elements of the coalition, experienced little resistance. The attack turned to rout almost immediately and few weapons or tactics can be considered battle tested or validated. The Tube-Launched, Optically Tracked, Wire Guided (TOW) missile, and to a much lesser degree the MEF's tanks, dominated the antiarmor battle with average engagement ranges in excess of 2,000 meters. Both the M60A1 and M1A1 tanks operated superbly and without challenge. This success must be considered, however, against an enemy that for whatever reason remained immobile, totally surrendered the initiative both in the air and on the ground, and was not inclined to offer significant resistance.

In the air, the joint air forces carved out an altitude safe haven that assured a generally benign environment over the theater. Ironically, while assuring relatively safe flying, altitude restrictions made it extremely difficult for aircrews to acquire and accurately attack targets. Evidence certainly indicates that incessant air attacks had significant impact on the morale of the Iraqi soldier in the MEF's area of operation. Evidence also indicates, however, that in a relative sense, it did not destroy or disable many armored vehicles, much of his logistics nor many of his soldiers. We must exercise extreme caution before embarking upon any development or acquisition course that involves expensive precision-guided systems, in an effort to rectify perceived aviation shortfalls.

For the first time in the American experience fratricide has accounted for a significant percentage of friendly casualties. Both ground and air incidents occurred, but in those cases involving aircraft, casualties were higher and more deadly. Vehicle marking, tactical boundaries and coordination at all levels did not seem to affect the outcome. The root cause of friendly fire seemed to be a loss of situational awareness on the part of personnel, and perhaps an attempt to integrate far too many systems into the close battle. Aircrews in particular feel we are

attempting to integrate air power into the ground-tactical battle far too often, and, therefore, limiting the full potential of this arm and its use by the commander.

Although the Iraqi force structure presented a potentially formidable electronic threat, ground and air elements of the MEF tended to operate with an over reliance on electronic communication. Frequent comments, particularly by aircrews commenting on ground stations, indicated a lack of respect for this aspect of modern combat operations.

MEF forces considered themselves generally prepared to survive but not capable of fighting in nuclear, biological and chemical conditions upon their arrival in the Persian Gulf. The weeks and months prior to the initiation of Desert Storm was considered a godsend, and by 17 January there was a high degree of confidence in the equipment and training relative to fighting in a contaminated environment.

The logistical support throughout both Desert Shield and Desert Storm is considered to have been a failure by those individuals charged with supplying and maintaining the force. This perception seems to have been caused, at least in part, by command decisions made by the MEF commander, based upon his view of the upcoming conflict. The fact remains, however, that those interviewed had an extremely jaundiced view of the support they received, and little confidence in the outcome of the conflict had the enemy decided to resist.

The reserve component receive high marks at the company/battery level of command. It is generally agreed, however, that above this level the unit's ability to execute its mission is lacking.

The reorienting of a military organization's fundamental war fighting philosophy is not a simple task, and this is obvious from the study's look at doctrine and tactics. There is a good deal of "buzz word" Maneuver Warfare, but it is obviously a process that has a long way to evolve before we can consider it institutionalized.

The study concludes that it is vital that we glean from this experience any relevant lessons for the future. It cautions, however, that we do not over react. We should ensure that all of the lessons we draw can stand the test independent of such factors as the physical environment, and lack of resistance on the part of the Iraqi.

We should also not draw conclusions on behalf of any potential belligerent. The lesson of Desert Storm may not be that the United States is a force that should never be challenged. It could be that Desert Storm has provided would be adversaries strengths and capabilities upon which to orient.

ANALYSIS

Introduction.

The Battle Assessment Team's (BAT) armor/antiarmor team was tasked to collect information and to analyze the armor, antiarmor and mechanized aspects of the Marine Expeditionary Force's (MEF) operations in Desert Shield and Desert Storm. The effort focused on interviewing any member of the MEF, regardless of military occupational specialty (MOS) or service component, who fired an antiarmor weapon (Dragon, TOW, rocket, 25mm gun, tank main gun or assault amphibious vehicle (AAV) weapon station) during either Desert Shield or Desert Storm. It was considered to be just as relevant to collect data from individuals who may have missed the target, or experienced an erratic or malfunctioning weapon, as it was to collect experiences from gunners or crews who claimed to have hit the target. Additionally, the team looked to get a sense as to what armor/antiarmor and mechanized tactics, techniques and procedures were employed by I MEF units.

Methodology. The methodology, collection activities and ultimate analysis rested upon three distinct elements: both individual and group interviews, survey and tactical evaluation of the entire Kuwait Theater of Operations (KTO) battlefield, and the experience and knowledge of the team members themselves. In fact the success of the armor/antiarmor effort was due in no small part to the fact that the four permanent team members were all experienced and highly qualified within their MOSs. Specifically, there was an infantry major (0302), an assault amphibian lieutenant (1803) and a captain and lieutenant both of whom were armor officers (1802).

Our intent as interviewers, and the team considers itself highly successful in this regard, was to listen and not lead, and to the greatest degree possible to eliminate any personal bias we might bring to the topic. The team produced nearly 100 audio hour-long tapes. The team also produced 424 individual gunnery engagement questionnaires, which are counted within the interview totals.

In excess of 500 interviews were conducted by the four antiarmor team members and included conversations with commanders and staff officers, section leaders, vehicle crews and individual gunners. Many of the interviews began with a formatted list of questions that was used as a guide, and had been developed prior to the team's deployment to South-West Asia (SWA). The length of an individual interview ranged from 5-90 minutes, with the norm being about 10-15 minutes. In conducting these interviews, team members did not simply run through the list of formatted questions in sequence, but rather asked the individual being interviewed to talk about his engagement, experience, etc., and the team member filled in the data as it was related. For example, rather than asking whether the engagement resulted in a mobility, crew or catastrophic kill, the interviewee was asked to describe what happened to the target after it was hit. Again, this would be asked only if the individual had omitted this item of information from his own comments.

The data collection scheme and process of analysis could not have been considered complete without a detailed look at various other aspects of the armor/antiarmor and mechanized battle. The team, therefore, examined in detail the physical and tactical aspects of the battlefield; the enemy

and how he operated; MEF training; combat support and combat service support (CSS); command, control and communications; equipment; reserves and issues related to doctrine and tactics. Finally, once the team returned to Quantico the effectiveness of the Aviation Combat Element (ACE) in the antiarmor battle was analyzed. This analysis was made possible by exploiting the interview tapes collected by the BAT's aviation team. This team was heavily augmented while still in Saudi Arabia by Marine pilots from the Marine Aviation Weapons and Tactics Squadron (MAWTS)-1.

Battlefield analysis was concurrent with the interview process and included a detailed--albeit non-technical--inspection of over 100 Iraqi main battle tanks (MBT), armored vehicles and artillery pieces (self-propelled and towed). This analysis also included inspection of dozens of Iraqi defensive positions, at times accompanied by Marines that had operated across the terrain under analysis. The analysis focused primarily over that portion of the KTO that MEF ground forces seized. Part of this effort, however, also included an extensive survey throughout the central and northern reaches of Kuwait, and well into southern Iraq. A survey was conducted north of Kuwait City and Al Jahra along the Al Jahra to Safwon, Iraq, road. Other aspects of this survey were the road networks northwest of Kuwait through the Al Mufrash region of southern Iraq, and the Al Jahra-Al Hujayjah-Umm Quost roads (northeast region of Kuwait in the vicinity of the Ar Rowdatayn oil fields).

External Sources. The team is confident that the data collected regarding individual engagements represents an extremely high percentage (75%+) of the total ground antiarmor engagements throughout the MEF. The team is equally confident that its efforts to document the other aspects of the armor/antiarmor and mechanized battle were equally successful in painting a complete picture. The team also tapped into four external sources of information in order to broaden its perspective and gain an appreciation of Desert Storm outside the MEF area of responsibility. Specifically, the team conducted liaison with the U.S. Army Battle Liaison Team and with representatives from the U.S. Army Ballistic Research Lab (BRL) while still in SWA. The liaison with BRL continued after returning to the continental United States (CONUS). [The point of contact at BRL is Major Dick Kofrinke USA, U.S. Army Ballistic Research Lab, Aberdeen, MD 21005 (301-278-6293 AV 298-6293).] Liaison was also conducted with the U.S. Army Materiel Analyses Activity (AMSAA) [The point of contact at AMSAA is Mr. Wil Brooks, Senior Armor Analyst, AMSAA, Aberdeen, MD, 21005 (301-278-4608 AV 298-4608).]

Once re-deployed back to the CONUS the armor/antiarmor team enlisted the support of the Foreign Science and Technology Center (FSTC) in Charlottesville, Virginia. The FSTC also sent a team that travelled throughout (both MEF and Army zones) conducting a technical evaluation of Iraqi equipment to determine exactly what was present and, if applicable, what destroyed it. While deployed to SWA the team analyzed 195 pieces of destroyed Iraqi armor and various armored vehicles. As of this writing the FSTC effort has only just begun the task of evaluating its data as it has only recently returned from SWA. Data and impressions made available to the team by all these agencies have been included in the final BAT paper.[The point of contact at FSTC is either Captain Charles Snyder USA or Mr. Robert Talbott, Attn: Code CA3 (Armor Branch), Foreign Technology and Science Center, 220 7th Street, NE, Charlottesville VA, 22901-5396

Kuwait Theater Tactical Environment

Military Aspects of the KTO. The first step in any assessment or analysis of a military operation must be a detailed look at the tactical environment within which the opposing forces clashed. I MEF operated in the southern segment of the KTO, an area that for the purpose of this paper includes northern Saudi Arabia and south-central Kuwait. This entire area is relatively flat desert, almost completely devoid of vegetation, and totally unlike the Marine Corps' combat training center at Twentynine Palms CA. There is an almost total lack of mountains, hills, or broken terrain of any kind. In this environment the intervisibility, or ability to see line of sight (LOS) considering trees, buildings, etc., is commonly in excess of five kilometers. Gently rolling "slopes," however, routinely provided militarily significant reverse slope possibilities of 300-800 meters.

Visibility during the conflict, commencing with air operations on 16 January (17 January SWA local), was frequently impeded by rain, heavy clouds, humidity, morning fog and day-time haze and dust. A totally unexpected visibility factor emerged once the ground war commenced; one that for various periods of time during the 100 hour ground conflict completely covered the battlefield with a thick blanket of black smoke. Iraqi forces ignited over 500 oil wells and the resulting smoke frequently cut visibility to absolute zero.

In many instances the effect of this smoke was to turn day into night. At mid-day flashlights were required to read maps and thermal sights to move and shoot. Light-intensification devices (e.g., night-vision goggles, "starlight" scopes, etc.) were rendered completely useless by these conditions and were not functional during either day or night. Artillery and mortar illumination had no effect as it burst within or above the smoke cloud that created an opaque ceiling generally hovering within a few hundred feet above ground level (AGL). These conditions severely restricted the use of close-air support (CAS), although close-in fire support (CIFS) from attack helicopters was possible when the aircraft could get in under the smoke.

The terrain did not inhibit to any appreciable degree the rapid movement of tactical vehicles. There was almost no area where both wheeled and tracked vehicles could not travel with ease, and with almost no stress on track systems or vehicle suspensions. In the case of tanks and other armored vehicles the "smooth" terrain allowed vehicles to easily maintain their system's battle sight zero (BZO). The only limiting factor is a terrain phenomenon known as "sabkhas," or moist tidal flats that extend inland from the coast to a maximum of perhaps seven kilometers. Sabkhas are located almost exclusively in the far northern coastal region of Saudi Arabia and in the southern extremes of Kuwait. These features are extremely restrictive to all vehicular movement, particularly during the wet winter months. The sabkhas were a factor for I MEF activities during the defensive stage of Desert Shield, but not during Desert Storm as the force had moved inland and away from this area.

With the exception of the occasional beduin camp, there is only occasional evidence of human presence in the desert. This is not

necessarily the case from the altitude perspective of aircrews, but at or near ground level obvious landmarks are rare. In the absence of natural terrain features, however, the few man-made structures became critical for reference and navigation. This is true even with the proliferation of electronic means of navigation available to both ground and aviation components of the MEF (e.g., Global Positioning System (GPS), Inertial Navigation Systems (INS) and Position/Location Navigation System (PLRS)). Police posts, roads, pipe lines, pumping stations, high tension wires and burning oil fields all became significant during operations.

Iraqi Defenses. Iraqi defensive positions were numerous and, in the case of trench lines and "bunkers," were exceptionally difficult to detect at more than 10-15 meters from even the top of a tank, light armored vehicle (LAV) or AAV. This camouflaging effect was due in large measure to their being level with the desert, and without a berm or parapet. In most instances those interviewed commented that Iraqi soldiers would seem to "rise up out of the ground" to surrender, or suddenly "appear" out of the ground and dash a short distance only to again "disappear" without trace. Trenches were roughly 1.5 meters deep and sufficiently strong to allow tanks and other armored vehicles to crossover them without significant damage.

Trench lines were periodically interrupted by multi-roomed bunkers that in most instances had little overhead cover other than a single sheet of corrugated tin covered by an inch or less of loose sand. Although these bunkers provided living space and were invisible from the air or Ground Combat Element (GCE) side of the position, they provided virtually no ballistic protection from air or ground-delivered ordnance. It was the team's experience that upon inspection these bunkers were frequently full of food, water, ammunition and various other housekeeping and comfort provisions. Of particular note was the quantity of serviceable rocket propelled grenade launchers and vast amounts of ammunition for this weapon.

Although not obvious by visible bunkers or trench lines, the general trace of enemy defensive positions could be detected from long-range by the presence of dug-in Iraqi tanks (primarily of the Type 69 or T-55 variety). These tanks served as anchors to bolster infantry positions. Terrain allowing, the tanks were most frequently below ground level with the main gun just above the desert floor. On the ground, and in the immediate vicinity of the gun muzzle, there was a layer of stone tiles, bricks, canvas, etc., an attempt to limit the main gun blast signature caused by blown sand and dust. There were cases where the vehicles were above ground level, but dug-in on three sides with only the turret clear above the earthen revetment. Whether dug-in or revetted both arrangements provided for immediate vehicular exit from the position. Tank positions were at times protected on one or more sides by anti-antitank guided missile (ATGM) screens (fabricated 3x3 meter heavy wire screens).

Conspicuous by their absence were any sort of tiered fighting positions for the revetted armored vehicles that would allow the crews to go into and out of total defilade as desired. There were also no alternate or supplementary positions of any kind (infantry or vehicle) that would have provided defenders the capability to protect the flanks or rear of their defense. The absence of either of these two fundamental defensive techniques made simple the task of taking their positions in the

flank or rear, or bypassing them altogether and rendering them irrelevant.

All of these positions would have provided the Iraqi soldiers some degree of protection had they elected to fight from them; although consistently positioning these tank positions on forward slopes exposed them to the long-range fires of every weapon in the MEF. There was no evidence that Iraqi commanders had attempted to exploit the absolute advantages inherent to reverse slope positions in this environment.

The tactical environment was to a very large degree a positive factor for U.S. forces and undoubtedly maximized the effect of all the weapons, vehicles, technologically advanced sighting systems, etc., in the inventory. As in the case of terrain, Iraqi operational dispositions also played a positive role in increasing the effectiveness of not simply hardware, but also the doctrine, tactics and style of warfare the MEF brought with it to the theater. The Iraqi command's placement of major elements of its force structure in highly linear and static defensive lines, played to the Marine Air-Ground Task Force's (MAGTF) strengths of mobility and immediately available, focused and fully integrated air power. At the tactical level the same comments apply. Static and linear defenses on forward slopes with no attempt to apply simple camouflage techniques to counter thermal or infrared (IR) imagery, exposed the Iraqi soldier to long-range observation and destruction. Deploying the bulk of his forces in theater to defend against an anticipated amphibious assault was also a significant contribution to the MEF's overall success.

The KTO and the Expeditionary Environment

The Expeditionary Environment. In analyzing the KTO from the perspective of actual MEF operations in Desert Shield and Desert Storm, it is important to keep in mind that this area of the world represents only one of a number of potential deployment possibilities for the nation's expeditionary forces. The Marine Corps' Expeditionary Intelligence Study 1-89 lists 69 nations, including at least three archipelagos, that are of specific interest to Fleet Marine Force (FMF) planners in the execution of their task to provide "rapidly deployable forces for contingency missions in support of national strategy." Conditions in the KTO are in most cases unique and to a large degree establish the extreme end of the spectrum in terms of the worldwide expeditionary environment. (1)

Expeditionary Characteristics of the KTO. At the strategic and operational level U.S. forces had the luxury of deploying into a totally benign environment with a first class infrastructure in terms of modern maritime and air facilities. These conditions facilitated the deployment of the multinational forces that in terms of the U.S. buildup alone included 21,976 transport aircraft sorties (cargo and personnel) and over 400 merchant ships, prior to the commencement of hostilities. The primary points of embarkation for both the air and maritime reinforcement effort were well within 200 kilometers of the Kuwait-Saudi Arabian border yet the Iraqi command accommodated the multi-national forces by waiting patiently for the critical buildup to be completed. Although the Iraqi armed forces did not include naval forces of any size or capability it did, however, possess a sizable air force that had the potential of interdicting the buildup. This fact was particularly true during the initial weeks of the crisis. The Iraqi order of battle also possessed the ground force capability to seize these facilities with relative ease as they had

demonstrated with their August seizure of Kuwait.

In overall terms of tactical advantages and disadvantages the KTO stands unique within the expeditionary environment. The theater served as a combat multiplier for U.S. forces and enhanced the performance of equipment. The almost total lack of concealment, intervisibility, superb off-road mobility, etc., all maximized the effectiveness of the MEF's systems. It must be kept foremost in our minds as we analyze or evaluate that within the general scheme of the expeditionary environment, the KTO represents an anomaly in terms of these characteristics.

Iraqi Equipment

Sources and Numbers. Although the Iraqi order of battle and table of equipment made it the fourth largest land army in the world, it consisted largely of Soviet export equipment that in most respects reflects vintage 1950s, 1960s and early 1970s technology. Other Iraqi equipment, command and control technology, etc., was, to a lesser degree, acquired from Britain, Brazil, China, France, Italy, Kuwait (captured) and the United States. In summary, although formidable in numbers the Iraqi military infrastructure was at best a generation or more behind its most advanced coalition opponents.

It has proved impossible to tally exactly the number and types of Iraqi armored vehicles and indirect fire assets operating within the MEF's portion of the KTO. As a working figure, based upon the what was considered to be at best marginal intelligence estimates, MEF planners were after roughly 1,900 of the Iraqi capability in individual tanks, armored vehicles and artillery pieces. This figure does not include other targets on the MEF commander's priority list (e.g., nuclear, biological, chemical capabilities (NBC), logistic facilities, command and control sites and infantry positions).

Models and Generation. In the case of MBTs the overwhelming majority of vehicles confronting MEF forces were of the Type 69 and T-54/55 variety. The third most common MBT, although rare, was the T-62. Finally, the T-72 MBT was encountered, but in insignificant numbers. In fact the absence of significant numbers of T-72s, destroyed or otherwise, in Kuwait and Iraq, lead both BAT and FSTC teams to surmise that these vehicles were either never deployed against U.S. forces, or were withdrawn prior to the initiation of hostilities. The limited number of T-72s in the Army zone in Iraq was a surprise to both the BAT and FSTC teams. The analysis conducted to date by the FSTC team, and impressions from the armor/antiarmor team's survey of the area, determined that the variety and numbers of MBTs in the Army area of operations were approximately the same as those in the MEF zone.

Many Iraqi MBTs had some degree of local modification, but modifications tended to be occasional rather than standardized throughout the force. Of particular note is that the Iraqi forces possessed no thermal imagery capability, forcing it in effect to fight blind relative to MEF forces.

In the case of the T-55/69 MBT, potential, but seldom or never actually seen on the battlefield, modifications included an up-gunned version with automatic loader, passive night sights of the

light-intensification ("starlight") variety, smoke grenade launchers and non-metallic hull skirts. In two instances T-55/69 MBTs were observed with "boxes" of locally fabricated applique armor. This package had been reported in the 1990-1991 edition of Jane's AFV Retro-Fit Systems as being similar in appearance to the Israeli "Toga" add-on armor, weighing 1250 kilograms, and hung on the glacis, front hull and suspension, and the front, sides and part of the turret rear. (2) Inspection of captured equipment revealed these boxes to be alternate layers of common and easily obtainable material. Although simple to construct and in the world of technological innovation considered literally "no tech," they have been tested and found to provide considerable protection from various chemical energy (CE) antiarmor ordnance.

The T-72 MBT was the pride of the Iraqi armored fleet but counted for less than 10% of the total estimated armor vehicles in the national inventory. As in the case of the T-55 and Type 69, the T-72 comes in a number of models with various Iraqi modifications. Of particular note was the presence of various types of advanced and applique armor (e.g., 30mm of additional steel armor on the glacis). Other enhancements included grenade launchers; coincidence, and in some cases, laser range finders; and passive night devices. (3) Occasionally T-72s were equipped with first generation electro-optical countermeasures (high intensity pulse source) designed to defeat weapons like the TOW and Dragon that rely on infrared guidance systems.

There were a number of armored personnel carriers, infantry fighting vehicles, self-propelled artillery pieces, command vehicles, etc., within the Iraqi force structure. These vehicles can generally be considered "soft skinned" although some applique protection was utilized on an occasional basis. As in the case of the T-72s, there was a surprisingly small number throughout Kuwait and Iraq of the most advanced personnel carriers in the Iraqi inventory, particularly the BMP-1 and BMP-2.

The Iraqi military had an impressive array of equipment in virtually every category that one might use to measure a modern military force. What the Iraqis did not have was state-of-the-art equipment relative to U.S. forces. Without thermal sights the Iraqi was blind at night, and for one entire 24 hour period of the 50 hour ground advance, due to oil smoke complications. His MBT gunners were out-ranged by two kilometers in comparison to the M1A1 tank and TOW systems of the MEF. The armor plate of his tanks and armored vehicles, some of which included advanced armor design, was no match for any of the MEF's antitank weapons. Electronically he was deep in the 1960s, a fact that negated his command and control, and guided air-defense systems. No doubt the Iraqi military was powerfully equipped, but it was after all a Third World force fighting out of its league, against a military equipped to fight and theoretically win against the Soviets.

Iraqi's Military Performance

Perhaps the most unusual characteristic in not only comparing the KTO to other expeditionary theaters, but also in putting the armor/antiarmor battle in context, was the nature of the enemy U.S. forces were "pitted" against. Iraqi forces demonstrated an almost total unwillingness or inability to fight in the air or on the ground. The arguments as to why the Iraqi did not fight are numerous and differing points of view exist;

the fact remains, however, that with few exceptions, he did not fight in a way consistent with his size, equipment or most recent operational experience (Iran War 1980-1988).

In the war with Iran, Iraq was forced by early 1984 to drop its static defensive strategy or be ground down by overwhelming Iranian numbers. Assuming that the Iranians could always build sufficient combat power at the place of their choosing, and effect a penetration almost at will, Iraqi commanders were forced to a flexible and more mobile defense. By 1984, and through the end of the war, elements of the Iraqi Armed Forces demonstrated the capability to execute combined-arms operations, integrating fire support, close air support and armor-heavy maneuver forces. (4)

Typically the Iraqis drew the Iranians into obstacle and mine field systems sighted for massed antiarmor engagements, hammered the largely foot mobile Iranians with air and indirect fire, and broke up the attack with armored counterattacks into the flanks of the penetration. In essence, they had to a large degree thrown off the methodical Soviet tactical style, and executed operations more in line with Western tactical methods. (5) None of this operational expertise was ever demonstrated during Desert Shield or Desert Storm. With the exception of possibly two, and certainly not more than three, instances in the entire conflict, the Iraqis never attempted an armored counterattack of more than a brigade(-) in size. In addition, Iraqi use of supporting arms was sporadic and consistently ineffective.

The MEF's GCE began accepting enemy prisoners of war (EPW) into its lines around 17 January 1991. By the opening of the ground conflict over 302 had arrived. Once Central Command's (CENTCOM) ground attack was initiated by the MEF, EPW accounting peaked at over 8,000 in a single day when the system was finally overwhelmed. The MEF overall total of EPWs processed was over 20,000 in the four day ground conflict.

Members of the GCE repeatedly stated that once fire of any kind was placed in the vicinity of a defensive position, almost invariably a small group of Iraqis would appear out of the ground waving white cloth or surrender leaflets (referred to as "liberty chits" by the Marines). Once it was obvious that this group would not to be harmed by the advancing force, masses of Iraqi soldiers would rise up and surrender. It was quickly obvious to the GCE's most forward combat formations that the surrendering Iraqi soldier was not a threat, that security and accountability was not required, and that by simply pointing Iraqi personnel south, their EPW handling responsibilities were complete. The tactical problem was more of how to process large numbers of EPWs rather than the expected difficulties normally associated with modern combat operations.

The one item in the Iraqi order of battle that if present, even with equipment and armament far below the quality and capability available to U.S. forces, would have made the invasion to retake Kuwait a bloody contest, was the fabric of the Iraqi soldier. One need only consider for a moment what use the North Vietnamese or Afghani Mujahadeen might have had for the same equipment. The Iraqi Army was overwhelmed by the combat power of the MEF, but, more importantly, by the way in which that combat power was applied against it.

MEF Training

For the purpose of this paper the period considered for training commenced in August 1990 and terminated in late December 1990 when the MEF began its movement to assembly areas and attack positions along the Saudi Arabian-Kuwait border. During the earliest stage of Desert Shield (August to mid-September) the single GCE deployed at the time was required to assume defensive positions north of the Saudi Arabian city of AL Jubail. At this time the opportunity to train was at a minimum. As Desert Shield shifted to buildup and preparation for offensive operations, however, training for Desert Storm commenced. As a general comment, MEF training was severely restricted due largely to official Saudi Arabian sensitivities regarding their desire not to appear provocative in the eyes of the Iraqi government. Other problems included a perceived lack of ranges, ammunition, fuel and other classes of CSS, and as stated above, the force's initial defensive posture.

Live Fire. There was no live-fire training to speak of during Desert Shield. Tanks fired only to bore sight and BZO their main guns, and AAVs fired to test their weapon(s) (in most cases 50 rounds or less). Although some familiarization training took place with antiarmor rockets, few weapons were actually fired or handled by potential users. Of note here is that on the modern-nonlinear battlefield users of antiarmor rockets potentially include every member of a given force. For example, there were occasions when individuals were reading the directions on the Light Antiarmor/Assault Weapon (LAAW) while they were preparing the rocket for use against enemy vehicles. At least one TOW and one Dragon gunner fired missiles during the conflict without ever having previously fired one in training.

A similar situation existed with AAV crewmen who fell in on vehicles off Maritime Prepositioning Force (MPF) shipping. MPF embarked AAVs were equipped with electric drive weapon stations (EDWS), as opposed to the more modern up-gunned weapon station (UGWS) currently in use throughout the FMF. The EDWS is the old model AAV turret with the M-85 .50 cal. machine gun. These older systems have been phased out of the FMF over the last three years. AAV crewmen trained on the UGWS employed the EDWS in combat with inadequate training and only some familiarization firing.

Live Fire-Maneuver. There was no integrated live fire-maneuver training prior to G-day (opening of the ground conflict). There was also a lack of integrated training for infantry formations. Although the conflict was dominated by long-range weapon systems, the core element of the combined arms team remained the MEF's infantry units. In terms of the numbers of Iraqi infantry positions, strong points, etc., there was great potential for disaster even as the GCEs bypassed obvious enemy surfaces. In the ground conflict various infantry units were in fact required to dismount and reduce trench and bunker systems, as well as some building clearing operations. Among all small unit infantry tasks strong point reduction and fighting in built-up areas are arguably the most difficult. These operations require intensive and highly specialized battle drill techniques and procedures, split second timings, and special task organizations. There was no live fire training in these two tasks with units often tentative, and at times initially confused, when confronted with the task of executing these missions for the first time with live

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ammunition against a "defending" enemy.

The ACE experienced similar frustrations with regard to the integration of forward air and attack aircrews. During the air campaign, training of this kind presented problems in both integration, as well as in the actual identification of targets.

Maneuver. Armor-mechanized maneuver training only those units with a 2-4 month training advantage. Desert Storm were satisfied with the amount of training. In some cases critical long-term relationships between infantry units were not developed. With the exception of (Company C, 4th Tank Battalion), all reserve tank and armor units in theater at least 60 days prior to the opening of the campaign. These reserve units were felt to have received sufficient training at the company/battery and platoon levels, but training time was considered insufficient by many for battalion staffs to gain required operational expertise. There was extensive training and rehearsals for the participation of armored units in obstacle breaching operations, and in point of fact, this was considered by many to be the primary training emphasis for Desert Storm.

There is little doubt that the MEF was ready on 24 February 1991 to breach the Iraqi defensive works and participate in the mission of reclaiming Kuwait. With the possible exception of NBC they were confident and ready to go upon arrival in SWA. What time was spent in theater prior to crossing the Saudi "berm" (border) into Kuwait, can be best considered a well-appreciated period of enhancement and reinforcement. There were some perceived shortfalls in time spent executing live fire, and live fire and maneuver training. Perhaps additional pressure placed upon the host nation at the highest levels would have solved this check to more realistic training.

Target Acquisition

Location and Identification. The two problems fundamental to the engagement of a target with any weapon system are, target location and target identification friend-of-foe (IFF). The solutions to these problems have become more and not less complex as weapons have grown in sophistication and potential engagement ranges have increased significantly. It is obvious that the fixed and obvious power plant, command center or hardened aircraft shelter are all at immediate risk and open to pinpoint destruction to a degree thought impossible even a decade ago. This is a lesson demonstrated to the world time and again during Desert Storm. On the other hand the process of specifically locating infantry and artillery units, armored vehicles, logistical sites, etc., that are dispersed and to one degree or another camouflaged, apparently remains an elusive capability. This fact is particularly notable when the unique characteristics of the KTO are considered.

The process of final location, identification and engagement of a target remains a function of the individual gunner or pilot. It is ultimately the human eye that acquires or detects the potential target and the brain that decides if the engagement will be made. Thermal sights,

Forward Looking Infrared (FLIR) and radar imagery are all enhancements to the eye, and designation by Light Amplification by Stimulated Emission of Radiation (laser), computer processing, etc., serve as assists in the decision process. The relative efficiency of locating and identifying point targets depends upon the following factors: visibility and intervisibility; range; target activity (moving or stationary); degree of camouflage and physical exposure; speed; and in the case of aircraft, the altitude of the engaging aircraft.

Detection Studies and Analysis. Numerous studies have tested the ability of the aided and unaided eye to initially detect and then distinguish or classify various tactical objects at varying ranges. Studies also have been contracted to estimate average engagement ranges in various regions of the world in which U.S. forces might be deployed. In the course of its analysis the armor/antiarmor team researched this problem as it has a direct relation on what bearing the effectiveness of various systems had in theater.

The most interesting study was entitled Analysis of Heavy AntiArmor Weapon Alternatives, and more specifically Appendix A of this study. The study was conducted by the Center for Naval Analyses for the Marine Corps in support of future ATGM decisions. Appendix A quotes the results of four relevant studies on terrain, visibility, probability of detection, exposure probability, etc., conducted by the U.S. Army Systems Analysis Activity (two studies) and Combat Developments Experimentation Center (two studies). A fifth reference to the appendix is a study conducted by the Australian Department of Defence, again, a work relevant to the ability to distinguish potential targets at various ranges. Although conducted with a focus on ground system development, much of the data is applicable to visibility from the aspect of ground or aviation systems.

One segment of the Australian study is of special interest as it considered analysis conducted on "relatively flat terrain with open vegetation." One of the study's findings is obvious and states that "at longer ranges, even if LOS exists, detection is quite difficult." It cites further references that indicate that "in ideal weather conditions, a fully exposed drab-colored tank-sized object can be detected against a drab-colored background by the unaided eye at a maximum range of 4,000 meters. This increases to 5,000 meters if the tank is moving or if binoculars are used." Specifically the study indicates the following probabilities of detecting a tank:

Range (m)	Moving	Stationary
1,000	--	--
2,000 (6,560 feet)	.92	.88
3,000 (9,850 feet)*	.81	.67
4,000 (13,000 feet)	.60	.20
5,000 (16,400 feet)**	.10	00

NOTES:

This table displays the probability of detection, given LOS.

* This figure represents the approximate limit AGL where aircrews released ordnance in SWA

** This figure represents the approximate point AGL above which aircrews in SWA commenced their attack or FAC(A) runs.

Table 1. Detection Probability In Ideal Visibility Conditions

All of these tests make the point that the problem only begins with detection, although this part of the engagement process would seem to be the most difficult. Once detected, the individual controlling the engagement must then IFF the target and finally execute the attack procedure(s) required by the specific system in use. The tests also assume ideal conditions for the individual tasked to engage the detected and identified target. The tests do not take into consideration actual battlefield conditions (e.g., smoke, dust, weather conditions, etc.) as they are impossible to replicate, especially the human factors of fear, fatigue, experience, anticipation, etc.

Even on a battlefield that has come to be dominated by lasers, overhead and thermal imagery, FLIR, highly precise and long-range systems, etc., these studies indicate that the ability to acquire and IFF targets beyond 2,000 meters in ideal circumstances is marginal, even in the maximum intervisibility conditions present in Kuwait. Compare this against the Expeditionary Intelligence Study 1-89 that indicates that in the overwhelming percentage of cases LOS distance will be under 1,000 meters, and it becomes evident that the problem is compounded even more throughout the rest of the world. (6)

Ground Operations

MEF Armor/Mechanized Assets. Any conclusions one may draw from the combined air-ground campaign must be viewed through the filter of the KTO's unique characteristics. As discussed previously, the terrain and physical environment was a critical factor and in reality served as a combat multiplier for coalition forces. The almost total lack of concealment, ideal intervisibility and mobility conditions, etc., maximized the effectiveness of our systems. These advantages, combined, with the enemy's unwillingness to fight, skew any lessons or results.

Armored units of the MEF's GCEs were equipped primarily with the M60A1 tank but received a battalion of M1A1 "Abrams" tanks during the final stages of Desert Shield. The M1A1 was undoubtedly the best tank on the battlefield. Marine and Army (Tiger Brigade) gunners successfully engaged targets at 3000+ meters and recorded first round hits while shooting on the move. Although the Abrams clearly had a number of advantages in the KTO over every model Iraqi tank, and for that matter the M60A1, it was the vehicle's thermal sight and laser-range finder that provided the crew the capability to dominate the armored battlefield.

A second notable advantage was the vehicle's ability to burn fuels other than Diesel Fuel (DF-2). Due in large measure to CENTCOM's single fuel policy, the predominant fuel in theater was Jeta (JA)-1. The Abrams experienced no difficulty in burning fuels other than DF-2, as did all other diesel burning engines, but like the M60A1, by burning JA-1 the Abrams was robbed of its capability to produce self-screening smoke. In an environment that was clear of vegetation and with little obvious terrain behind which to hide, this was a distinct disadvantage to the

tank's survival, and could very well could have been a critical factor had the enemy utilized to any degree his formidable stock of ATGMs.

M1A1s deployed with the GCE sustained no direct fire or aviation ordnance battle damage, although the U.S. Army did. Specifics on these engagements were not available as of this writing, but information provided by the Army's BRL indicates that in every case the tank's inherent crew survival systems functioned as designed. Information regarding this topic can be requested through Lieutenant General Billy Thomas, Deputy Commanding General, U.S. Army Material Command, Alexandria, Virginia 22304-6145.

Like the Abrams, the M60A1 was also highly effective and provided crews with the ability to engage targets out to 2000+ meters. There are, however, some problems and shortfalls that must be noted. In some instances reactive armor for the M60A1 was in short supply. For example, in the case of the 8th Tank Battalion USMCR (attached to the 2d Division), there was only sufficient reactive armor to cover the gun mantlet. A significant limitation was realized in the M60A1's ability to identify and engage targets at night or during periods of reduced visibility. As with all night sights and vision devices that were not thermal, the M60A1's systems were largely ineffective during the conflict. Even when conditions favored the use of such devices, as when oil smoke was not a factor, sand, dust and haze limited effective vision ranges to less than 1000 meters. This was true of all devices that relied on light-intensification technology. Also of note is the M60A1's optical-range finder's inability to achieve a clear "ghost image" due to normal battlefield obscuration. This condition forced crews to apply "battlesight" vice "precision" gunnery during engagements.

Unlike the M1A1, the M60A1 experienced serious performance problems burning fuels other than DF-2. In particular, the tank was under-powered during acceleration and suffered a significant increase in fuel consumption. The fuels were also responsible for continual problems relating to clogging of filters, pumps and injectors. As in the case of the M1A1, the M60A1 could not produce self-screening smoke. In this conflict and against this enemy, however, this shortfall did not prove a problem as no U.S. tank or armored vehicle was tested to any degree.

In the case of main gun effectiveness both the M1A1 (120mm) and M60A1 (105mm) were effective against any model Iraqi MBT, from any aspect, with both sabot and high explosive ammunition. The only comment worthy of note in this regard was that sabot rounds typically passed completely through the vehicle without causing an instantaneous catastrophic explosion. Crews reported a delay of from 1-4 minutes before the target exploded and burned. Crews were more impressed and confident with the immediate destruction associated with high explosive (HE) rounds and frequently switched accordingly. Engagements took place at an average range of 1,200 meters for the M60A1, and this without a thermal sight. The M1A1 had significantly longer average ranges, but the team collected insufficient data to provide a statistically valid average. Interviews with M1A1 crews generally placed engagements somewhat beyond 2,000 meters and almost always through the thermal sight.

GCE mechanized forces were mounted in AAVs. In the role of armored personnel carriers, AAVs provided suppressive fires on suspected enemy positions despite the limitations suffered by some vehicles outfitted with the older EDWS, and the low level of pre-conflict training. AAV suppressive fires were effective to 1,800 meters but only when the vehicle was stationary. The UGWS provided even greater capability in this role with its .50 cal. and 40mm machine guns. As a general comment, applique armor was not in sufficient supply to outfit the entire mechanized force, particularly in the 2d Division.

Employment of the light armored infantry (LAI) battalions was a critical aspect of GCE operations both in Desert Shield and Desert Storm. The concept of the battalion's employment as a screen, guard and cover force can be considered validated as these units, perhaps more than any others, were in frequent, and at times sustained, contact with Iraqi forces. Although no substitute for a MBT, LAVs proved lethal and demonstrated the speed and agility to perform in the presence of hostile armored forces. Of particular note was the increased effectiveness achieved once the LAV-25s were fitted with externally mounted thermal sights. Only the LAV antitank variant (LAV-AT) comes equipped with an organic thermal sight.

The 25mm chain gun proved effective in every engagement against Iraqi armored fighting vehicles, personnel carriers, etc. Short bursts of from 3-7 HE rounds were sufficient to cause immediate burning and eventual catastrophic destruction of the vehicle. The 25mm ammunition in use by the GCE was not able to penetrate Iraqi tanks. Tiger Brigade crews reported that penetration and destruction of T-55/69 MBTs was commonplace with the identical 25mm gun mounted on the "Bradley" fighting vehicle. The difference in effectiveness is in the depleted uranium (DU) ordnance fired by Army crews. The effectiveness of the gun firing this ammunition was verified by the BRL in Aberdeen.

LAI-AT (TOW) crewmen literally demand an improvement in how rapidly the Emerson "901" Turret ("hammerhead") can be deployed and fired. In addition to the time it takes to raise the system (up to 30 seconds), the missile guidance system has to be re-boresighted after every vehicle move (boresighting can take as long as four minutes). Crewmen reference the Bradley (fighting vehicle) that can stop, deploy and shoot within 15-20 seconds.

ATGMs and Rockets. The TOW missile proved to be an unqualified success due in large measure to its range, its carrier's (High Mobility Multi-Wheeled Vehicle (HMMWV) and LAV-AT) speed and agility, and most notably to the thermal capability inherent to the system. LAI and HMMWV TOW gunners and crews had complete confidence in their systems. The thermal sight served not only as a weapon sight, but also in the role as eyes for the force, especially in the case of M60A1-equipped units. Typically HMMWV mounted TOWs led attack formations as only thermal sights provided the capability to penetrate through the dark, haze, battlefield obscuration or effects of oil smoke. It was also the most efficient means to acquire dug-in tanks or other armored vehicles at extended ranges (2500+ meters) in daylight. On the defensive or during halts it served as forward local security, although it is noisy and can be heard at night for up to 200 meters. Due to the obvious advantages of thermal imagery, every unit, regardless of mission or function, stated that a similar thermal capability

is essential for night operations.

TOW missile performance and reliability was good but models older than TOW-2A were considered less reliable. All TOW missiles that hit the intended target, regardless of model, reportedly killed anything on the battlefield, and from any aspect (frontal, flank or rear). In general the missiles seemed sensitive to heat and did not appear to take well the stresses placed upon the missile as a result of moving cross-country 100% of the time. This is an important observation, particularly in light of the KTO's trafficability characteristics described previously.

TOW engagements ranged (estimated) from a dangerous and wasteful 65 meters to the system's extreme range of 3,750 meters. There were 266 individual missile engagement interviews conducted. Of the engagements that took place between an estimated 65-1,000 meters, gunners achieved hits in only 43% of the cases (12 of 28 missiles). In the case of engagements from 1,000 meters to the extreme range of the system, gunners achieved hits 80% (184 of 232 missiles) of the time. Gunners achieved an overall hit average of 80% which is 10% less than the hit probability for the TOW published in the Joint Munitions Effects Manual (JMEM). Although the arming distance of the weapon is 65 meters, data would seem to suggest that the minimum effective range is at least 1,000 meters assuming LOS, adequate engagement window, etc.

Virtually all personnel feel that the addition of an internal laser-range finder and compass (viewed through the sight) would be invaluable additions to the system. The efficiency of the system would not only be increased in terms of target acquisition and speed of engagement, but would also accurately provide the solution for polar indirect-fire missions. HMMWV crewmen also want the vehicle antenna out of the way and a heavier bezel ring and fasten-down latch on the mount. These enhancements would result in fewer "lost" missiles and would expose only one of the crew outside of the vehicle during engagements.

There were few Dragons fired during the conflict due in large measure to overall average engagement ranges that generally far exceeded the maximum range of the system. This was the case even with the Dragon II and its extended range of 1,500 meters. A second factor was that the system is not vehicle-mounted and available for immediate action; rather it requires the gunner to deploy the missile out of a vehicle and on the ground. When the missile was employed against bunkers and armored vehicles, however, the Dragon hit and was effective against its target.

There were 27 recorded LAAW (66mm) and AT-4 (84mm) engagements against armored vehicles during the conflict. The LAAW and AT-4 were extremely effective against armored vehicles and in most cases catastrophically killed armored personnel carriers of any type. An unexpected surprise to MEF personnel of all ranks and billets was that there were LAAWs still in the system with the majority of Marines stating that they were unfamiliar with the weapon.

The Shoulder-Launched Multi-Purpose Assault Weapon (SMAW) was utilized in a small number of engagements with the weapon proving effective against bunkers as designed. There was no evidence that the SMAW was used against hostile tanks or armor during the conflict. A penetration test was

conducted (8th Marines) against a captured Iraqi T-72M utilizing four SMAW high explosive anti-armor (HEAA) rounds. The T-72 was down loaded of all ammunition and external fuel. The first round struck just below the underside of the front glacis of the tank and resulted in catastrophic damage (fire). The second round penetrated the turret ring area, the third successfully penetrated a road wheel and then the vehicle's lower hull. The fourth detonated against a suspension skirt with little damage to the vehicle.

Direct Fire Engagements. In characterizing the ground engagements against armor there are a number of salient points worth highlighting. First, in almost every case the target was stationary with no sign of Iraqi soldiers initially in evidence. Second, in most cases the target was not firing nor did the gunner or crew consider themselves under fire from any source. Third, in virtually all antiarmor engagements, regardless of weapon employed, the most common result was an almost instantaneous and catastrophic explosion of the vehicle. This initial explosion was then followed by a series of secondary explosions and fire. This would indicate that these vehicles had not yet been hit by any other system capable of defeating an armored vehicle. Fourth, most of the armor engaged was of the Type 69 or T-55 variety that were dug-in (and therefore stationary) and unoccupied at the time of engagement. Lastly, gunners and crews were all following rules of engagement that included destroying by fire all Iraqi armor, and when in doubt as to its serviceability status, to fire and ensure it was out of action.

The evidence for drawing the conclusion that the vehicles were unoccupied and, therefore, one would guess undefended, is derived from the inspection of vehicles during the team's survey of the battlefield. Inspection of armor that was confirmed to be in motion when engaged (as with the T-72s north of Al Jaber Air Field destroyed by MIAs attached to 1st Battalion, 8th Marines), invariably had some amount of human remains contained within what was left of the crew compartment. In almost every case these remains were to be found in the driver's area up under the front glacis. Inspection also routinely revealed dismembered body parts strewn about the vehicle and within 25-50 meters.

Target Evaluation. In the rough estimation of the team, 90% of the 100 vehicles examined on the battlefield contained direct fire damage from either sabot, or large ground-delivered CE munitions (TOW or main gun HE). In the 10% that did not have this type of obvious ordnance impact, most had CE penetrations from a weapon fired or dropped AGL. In some instances within this 10% no evidence of any kind existed as to what destroyed the vehicle. In these cases it was presumed that the target was destroyed by explosive charge or incendiary device employed by passing elements of the GCE.

The FSTC team generally agreed with this assessment but their more systematic analysis placed the estimated number of targets destroyed in the MEF area by ground fire at 85-90%. The remaining vehicles were destroyed by air-delivered ordnance, primarily from attack helicopters. An interesting note is that in the Army zone where both Army and Air Force aviation assets were active, the FSTC team found 15-25% of the targets were obviously destroyed by air, again primarily by attack helicopters and to a lesser degree by "Maverick."

Air Operations

Central Command's Air Offensive. Phases I and II of the Commander-in-Chief's (CINC) air offensive were directed against strategic targets as well as in attempting to gain air supremacy in the KTO by striking at Iraq's integrated command, control and air defense systems. Phase III of CENTCOM's air offensive was an effort to shape the battlefield and prepare the way for future ground actions. Phase IV of the air effort was in support of the ground campaign once this phase of Desert Storm commenced.

The Marine Corps is unique in that it maintains an aviation element that includes both fixed and rotary wing aircraft. It is within this component of the MAGTF that much of its total combat power--tactical, operational and strategic--is located. In Desert Storm the ACE participated in all aspects of the air battle; but the majority of its efforts were directed against designated targets that were primarily either armored vehicles or towed artillery.

Shaping the Battlefield. The initial application of combat power in support of the MEF's operation plan was to shape the battlefield in such a way that once the ground offensive began, the GCE would face the minimum threat from massed indirect fire and/or armored counterattack, especially during breaching operations. Other aspects of the MEF commander's guidance was the attack of enemy command and control nodes, infantry positions and logistic sites. Consistent with the overall theater air campaign, the ACE was tasked by the MEF commander to reduce Iraqi artillery, maneuver forces and tactical command and control by a minimum of 50% prior to the initiation of ground operations. This percentage was a direct reflection of specific guidance from the CINC.

The actual prosecution of the ACE's mission evolved over a period of time. Once the MEF was designated as CENTCOM's supporting attack, intelligence acquired from joint and national systems (e.g., satellite imagery, Joint Surveillance Target Attack Radar System (JSTARS), etc.) was largely unavailable. Air missions were routinely developed from "marginal" intelligence generally 3-5 days old. In the initial few weeks of the campaign MEF aircrews were provided latitude and longitude coordinates to attack with little likelihood of the intended target being at that specific position. This is especially true considering the inherent inaccuracies associated with current aircraft INS navigation systems, and the fact that the MEF commander's priority targets were highly mobile systems, normally dug in, and regularly camouflaged.

With the air war almost a month old, and only two weeks remaining before the ground assault was scheduled to commence, a new look was taken at the battlefield and the direction and effectiveness of the ACE's efforts. After conducting the detailed process known as intelligence preparation of the battlefield (IPB), it became obvious that many of the inconsistencies in terms of the Iraqi order-of-battle arrayed before MEF forces were due to the enemy's efforts to stay mobile and avoid being fixed by U.S. intelligence assets. Further study indicated that the enemy was rotating through prepared positions every 2-4 days and that it was possible to predict with an estimated 95% assurance, the general area in which enemy division-sized formations could be found.

The IPB effort produced a series of target "boxes" that were designated as either maneuver or artillery. The size of the boxes ranged from 50-150 square kilometers with an average of approximately 90 square kilometers. With a high degree of probability that an entire Iraqi division's assets were contained within a designated box, the intent of the MEF targeting staff was to focus MEF air power in specific areas and against specific enemy capabilities.

The initial estimate by the MEF was that it would require 7,500 attack sorties, in the final 15 days prior to G-day, if the MEF commander's guidance of 50% attrition in the prioritized target categories was to be achieved (based upon JMEM calculations). As the Air Force could not provide the required supplemental sorties, the targeting staff was required to re-figure desired effects and establish new strike priorities based on an enemy unit's relative distance from the breach sites, type of armor, artillery, etc. The revised estimates required 5,000 sorties of which the ACE could generate 2,500 (ultimately generated 2,700). During this period an estimated 50% of these sorties were under the control of a FAC, with the remaining executed as armed reconnaissance.

FAC(A) and Attack Profiles. Attack profiles generally fell into two categories: the F/A-18s and A-6s were required to remain above 18,000-20,000 feet (5,000-6,000 meters); the AV-8s, 8,000-12,000 feet (2,400-3,600 meters). Liaison with the Air Force indicated that their pilots were required to follow the same general altitude restrictions. What dictated the altitude restrictions, and in point of fact a change in aerial tactics, was the Iraqi missile and anti-aircraft artillery (AAA) threat encountered in the theater. The threat condition experienced during the campaign was characterized by fixed-wing pilots as generally permissive or restrictive. Although surface-to-air missiles (SA or SAM) 2 through 16 were present within the Iraqi order-of-battle, and the associated radars were often encountered, the threat from these systems seldom materialized and was not considered by aircrews to be an impediment to their activities during Phase III or IV.

Rather than the expected and most commonly trained for "high threat" tactics of low-fast ingress to the target, the ACE utilized a high approach (16,000-20,000 feet) and bomb release (8,000-15,000 feet) throughout the campaign. These procedures kept the aircraft generally out of the sporadic AAA fire that was common on most missions. It also kept aircraft above the limits of the SA-16, the system reportedly responsible for all AV-8 losses, and for damage to a number of F/A-18s. Due to specific limitations in the AV-8's aerodynamics and performance characteristics when carrying a substantial load of bombs, rockets, electronic pods, 20mm ordnance and expendables (chaff and flares), and problems with its computer software and fusing relative to the use of MK 20 (Rockeye), it was required to operate between 8,000-12,000 feet during ordnance delivery. When delivering MK 82s and 83s (500 and 1,000 lbs.) the AV-8 remained above 10,000-12,000 feet. All aircraft flew evasively during target ingress and egress, and utilized defensive programs of flare and chaff when coming off targets.

Attack crews were universal in their praise of the effectiveness and efficiency of the so called "Fast-FACs" (FAC(A) performed by the F/A-18Ds). Common themes among the F/A-18D crews was that it was extremely difficult, and at times impossible, to locate targets, even with

the use of 10x50 binoculars in the cockpit. The feeling among these FAC-As was that the forces that were supposed to be on the battlefield either were not, or were so well hidden that they were not visible from the air. Other comments included difficulties with bomb damage assessments (BDA). The aircrews typically stated that assuming the object being attacked was in fact a tank or other priority target, BDA was a problem because unless there were secondary explosions, a kill or even a hit could not be assumed.

A typical FAC(A) mission as executed by the F/A-18Ds began with the aircraft arriving above the assigned maneuver or artillery box 30 minutes prior to the attack aircraft's (section or division) checking in. The FAC(A) crews would then commence their search for a target(s). Upon arrival the attack crews were provided an abbreviated line brief, subsequent to which the FAC(A) would mark the target with a 5 inch or much less preferred 2.75 white phosphorus (WP) rocket. The attack pilot was then given an adjustment off the WP mark.

Attack pilots also acknowledged the difficulty of acquiring targets even after marking by FAC(A)s and also that pilot BDA tend to be liberal rather than conservative. In almost all cases these crews argued for an enhanced capability to detect point targets; and in the case of AV-8, crews for more power, some armor on the aircraft and a night capability.

Phase IV was the actual support of ground operations, once this phase of Desert Storm commenced. There were few actual applications of CAS during the ground conflict. Although the ACE was prepared to surge aircraft for this purpose the lack of Iraqi resistance, the rapid nature of the GCE's attack, severe battlefield obscuration, and flight and altitude restrictions were all factors in minimizing the requirement for CAS. Of note in this regard was the inability of ground laser designators to maintain sufficient laser energy to make aerial attack by fixed wing systems possible. Other comments by aircrews included refusal on a number of occasions to deliver ordnance while under control of a ground FAC. These refusals were based primarily on a lack of confidence in the ground FAC's situational awareness as to what was going on around him. Few attack pilots expressed any degree of confidence in the ability to deliver ordnance in close proximity of friendly forces when these forces were moving and intermixed on the battlefield below.

ACE Effectiveness. It is very difficult to frame the ultimate effectiveness of the MEF air effort. From the perspective of cover and concealment, the KTO presented aviation with a deck stacked in its favor. As was the case on the ground, the much vaunted and perhaps overly feared Iraqi air defense threat never materialized. Phase II of the CINC's air offensive was apparently successful in rolling back all but the impossible to destroy AAA and SA-16 threats.

By their own actions the aviators had established an altitude safe haven from which to operate. The problem, however, was that by operating from within or just below the floor of the haven, it was difficult, if not in many cases impossible, to acquire the kind of targets on the MEF commander's priority list. In this respect the Iraqi armed forces may have had their greatest, and only success. The potential and frequent reality of AAA and SA-16 fire below 10,000-12,000 feet precipitated a change in aviation tactics, that in turn seriously degraded the ability of

aircrews to see and/or destroy the target.

The CINC and MEF commander were looking for 50% attrition of specific categories of Iraqi capabilities prior to G-day. The ACE's effort was Herculean but numbers or sorties generated or bombs dropped does not necessarily equate to tanks or artillery pieces destroyed. The effectiveness as to exactly how efficient in killing individual priority targets the air effort was, is best described by the FastFAC aircrews who flew the point on this effort. It is also evident in the MEF targeting staff who were confident that by G-day the number of targets destroyed was 15% or perhaps 20% in all categories. On the other hand perhaps the credit should go to the ACE not for destroying targets and killing Iraqis, but for terrorizing them in their defenses and eroding their will to fight.

Fratricide

One of the most comprehensive studies regarding the historical difficulties associated with fratricide was one done at Leavenworth's Combat Studies Institute. Amicide: The Problem of Friendly Fire in Modern War indicates that since World War I roughly 2% of casualties are caused by friendly fire with the primary cause the result of human error. (7) The gunner miscalculates data, the pilot programs the computer with the wrong codes, etc., are the most frequent occurrences that traditionally lead to fratricide. Target misidentification only began to grow as a significant factor since World War II, with the general wisdom placing the blame at the increased speeds and altitudes at which modern aircraft operate.

MEF units took a variety of different measures to limit the possibility of fratricide. Tactical boundaries, coordinated fire lines, restricted fire areas, fire support coordination lines (FSCL), etc., were established and disseminated. Vehicles were marked in accordance with CENTCOM instructions and some units placed IR strobe lights, "chemlight" sticks and air panels on vehicles as well.

MEF Incidents. Fratricide or "friendly fire," ground or air, was not infrequent during Desert Storm. The "blue-on-blue" air-to-ground incident involving an A-10 attack against an LAV during the Ra's al Khafji engagement is the obvious and most tragic incident. There were other instances within the MEF, but only one related to the armor/antiarmor study. On this second occasion an A-10 attacked and re-attacked a TOW squad. This incident occurred after 24 February within the 1st Division's zone and did not result in injury. There is some evidence in the interview that the aircraft was under the control of an OV-10. There were various reports of GCE units being attacked by ACE assets, although as stated above, as CAS was not integrated to any degree during the ground conflict incidents of this nature were few.

Among GCE units the origin of friendly fire generally originated from armored task forces and most often involved tank engagement. Friendly fire was turned off either by up-and-down or lateral communication. In some cases units under friendly fire attempted to stop the fire by the use of red pyrotechnics, but frequently this color projectile had a dissimilar meaning among units.

Aircrew Concerns. One of the most common themes among ACE aircrews was their great concern over attacking friendly forces. The difficulty of acquiring targets and achieving "situational awareness" while under the control of a FAC and short of the FSCL, did not make the aircrews comfortable with conducting CAS. This was the attitude even as pilots acknowledged the fact that the battlefield was relatively uncomplicated and friendly and hostile formations were not intertwined as would be considered normal. The crews reported that once the ground conflict began it was assumed that everything that was moving was friendly, as most activity was travelling generally north.

It is obvious from preliminary investigations of friendly fire that many of CENTCOM's incidents came as a result of attempting to integrate CAS and CIFS into the "close" battle. Perhaps, as Marine aircrews frequently opined, there is a point where the ground battle is too close, where the forces are too intermixed, and at that point the battle should generally be left in the capable hands of the GCE. CAS, to paraphrase the pilots, is and should be an option, but it possesses unique capabilities that should not necessarily be applied against targets that are better attacked by more responsive and surgical direct-fire systems that are under direct control of ground forces. Aircrews, particularly those in the FAC(A) squadrons, commented that ground FACs tended to call for air support on targets that were too close, and not appropriate for the special engagement capabilities provided by air-delivered ordnance.

Ground Gunner Concerns. In the case of the armor/antiarmor effort in SWA it was agreed upon by interviewees that the thermal sight in both the M1A1 and on the TOW does not provide sufficient clarity to IFF any tank or armored vehicle, with the exception of the AAV, beyond 1,500 meters. In many of these instances, however, gunners fired taking a calculated risk based on situational awareness and training. In other instances, AAVs, the most recognizable object on the battlefield according to the comments of many Marines, were fired on more than once by M60 tank crews shooting out of zone at 2,000 meters on a relatively clear day. It might be possible that the solution to the SWA incidents is not in hardware necessarily, but in doctrine, tactics and training.

Command/Control and Communications(C3)

Electronic Warfare(EW) and the KTO. In many respects the KTO was, from the perspective of MEF communicators, not a particularly friendly environment. The relative dryness of the soil prevented good electrical grounding of equipment, but distance between stations was the most difficult problem to overcome. LOS was not a problem in the KTO but Desert Storm was a high frequency (HF) conflict, as only HF provided the reach to communicate between commands. There were insufficient frequencies available for use by the force, HF radios and crypto (KY) equipment shortages were experienced particularly in AAV and armor units. Frequently only battalion and higher nets were covered in these organizations.

There was a general understanding throughout the force that the Iraqi forces possessed the hardware and doctrine to exploit the radio-electronic spectrum and conduct sophisticated EW operations. Jamming, intrusion and

direction finding (DF) was expected, and experienced, due both to Iraqi efforts and the MEF's over use of the spectrum. Of particular concern was the Iraqi potential to deliver large volumes of indirect fire against DFed units. Although aware of the threat, units often operated as if there were no threat. Even at the battalion level and below there was an almost total reliance on radio-electronic communication with seemingly little concern for minimizing the EW signature. As a general comment there was no difference in the use of electronic communication during the conflict than what is considered normal in training.

MEF C3. Generally speaking the traditional tactical control and fire support coordination measures were utilized down to the company, and in some instances platoon, levels. One of the divisions did not assign unit boundaries, but left it to subordinate units to work them out if required. All subordinate commanders established tactical boundaries and when in some cases the rapid pace of events made the re-establishment of these measures impossible, commanders and staff officers alike were extremely uncomfortable. In any case only the availability and use of position location devices made it possible for units to maintain boundaries in an attempt to "organize" the battlefield.

Position location devices were considered essential by all personnel within the MEF. GPS was the most reliable and was by far the most widely used. PLRS was completely unreliable once the ground conflict commenced as the base station apparently did not displace forward with maneuver forces. In essence the force out-ran the system. When it worked the system (PLRS) was considered effective. Over reliance on these systems should be avoided. An example of possible over reliance is the fact that in some instances armored attacks were led by HMMVs and AAVs as these vehicles had location systems and some tanks did not. There was little or no navigation training conducted without the use of location systems, with the exception of the attached Tiger Brigade.

Clearance to fire procedures were in place across the force. Among TOW (HMMWV and LAI) units permission to fire was requested at least through the section leader and often to the platoon commander. It varied among armor units but, most often requests to fire went to platoon and at times even company commanders. There was generally no stated reason for this procedure other than that it was the way it was done in training. Seldom was the individual granting permission to fire in a position to verify the requestor's target as hostile.

Although equipment was not a problem in ACE units, aircrews stated that KY procedures were inconvenient due to the time delay between keying the microphone and beginning to talk. Their point was that this delay has significant impact when operating at typical aircraft speeds and dealing with FACs of any kind.

Aircrews also expressed extreme frustration over the problems of communicating with ground FACs during attempted CAS missions. The frustration came from the jamming effect that ground FACs had on each other during operations. The aircraft radio and positioning AGL has sufficient power and efficiency to be heard by dozens of ground FACs simultaneously, but the FAC's equipment and position prevents him from receiving other FACs all of whom are attempting to get CAS at the same time. Again, there are comments here about the tendency on the part of

the GCE (FAC) to request CAS when from the pilot's perspective, the battle area is too complex to sort out which mark is the right one, or the FAC's laser designator is too weak to hold a "spot."

Also germane to the question of command and control is the frequent comment among vehicle crews that fire commands, so much a part of their peacetime training, proved burdensome or irrelevant and had little application to the realities of combat. Crews stated that most often things happen too fast and are too confused, and that potential targets appear too quickly and are frequently too close, to wait for a fire command. A process that requires a section leader or platoon commander to acquire potential targets, evaluate them, transmit this evaluation over a radio, and all from a point from which he may or may not be able to see one target let alone multiple targets, is unreasonable and unworkable.

C2 Concepts. Command and control is a conceptual as well as a hardware issue. In the case of equipment, there is a new generation--for the Marine Corps--of electronic communications assets, such as integrated data processors and frequency hopping radios, that will bring FMF units into the modern electronic era. The other issue is one that is more difficult to deal with as it is one of attitude, and has been institutionalized by our training and research and development efforts.

The exercise of command and control on the battlefield comes from a number of sources not the least of which should be, according to Warfighting (FMFM 1), mission orders and commander's intent. If a force acknowledges, as did the MEF personnel that were interviewed, that the enemy has the ability to fight credibly within the EW arena, then a reliance on other methods of communication might be prudent. Within the focus of armor/antiarmor the team found it confusing that well trained TOW or tank crews, who were confident in their own abilities to IFF vehicles, were required to request permission prior to each engagement. This is particularly difficult to understand when the requestor provided no information other than that he requested permission to fire, authorization was virtually automatic, and most often came from some leader higher in the chain who was not in a position to verify the intended target. This is one example of many, but it does indicate the continual desire on the part of whoever is next in the leadership chain to "control" or hold his subordinate on a tight string.

Nuclear, Chemical, Biological

Preparedness. A continual theme throughout the interviews, and therefore throughout the MEF, was that NBC training prior to either deployment of potential deployment to SWA had been either ignored, or approached as simply a check in the block. The only exception to this comment was the attached Tiger Brigade from the U.S. Army. Marine interviewees did not feel that they had been trained individually or collectively to operate in a chemical environment prior to their arrival in SWA. GCE combat arms units were somewhat more confident, but not to the degree that the seriousness of this issue might warrant.

NBC training in theater was comprehensive and built confidence in equipment and in the individual's ability to fight in the expected chemical environment. Marine and Army interviewees were universal in their appreciation for the weeks and months prior to the opening of

hostilities which were spent increasing proficiency in this critical area. There were concerns, however, particularly regarding the requirement to change mask filters after four hours and protective suits within 24. This concern was based upon insufficient stocks of critical items, such as decontamination equipment and water, protective suits, and the inability to change filters on the M17A2 field protective mask in a contaminated environment.

Equipment Issues and Concerns. MEF personnel of all ranks and billets pleaded for a protective mask that is both full faced for weapon sighting purposes, and allows immediate (20 seconds or less) filter replacement while in a contaminated environment. The M40 mask is currently under consideration for procurement by the Marine Corps and has been for nearly three years. Vehicle crewmen also require an enhanced mask that combines the advantages of both the current M17A2 and M25 (vehicle crewman) protective masks. Specifically, crewmen must have a mask that provides a full field of vision, allows verbal communication through the combat vehicle crewman helmet, allows water to be taken in and is effective when unplugged from the vehicle NBC system. A mask of this capability currently exists in the form of the M42 vehicle crewman protective mask, and was under consideration for purchase prior to Desert Storm.

A second major concern focused on medical evacuation (MEDEVAC) procedures as they relate to casualties in a contaminated environment. In modern war, particularly with the distances and decentralization associated with mechanized operations, vehicular or airborne evacuation of casualties is the single option for survival. The handling and decontamination of casualties prior to entering the MEDEVAC chain was seemingly never worked out to a degree that satisfied those interviewed. Finally, in the case of equipment heavy units, no large scale "decon" drills were conducted on ground (e.g., AAV, tank, truck, etc.) or aviation units.

While the MEF deployed to SWA with a lot of real or perceived shortfalls in its NBC capabilities, the fact of the matter is, however, that the force improved in this area literally overnight and to the point that personnel were confident in their ability to operate, for at least a short period, in a "dirty environment." All of the credit for this improvement would seem to belong to the dedicated and persistent NBC personnel within the MEF. Returning forces have a high degree of proficiency and awareness of the NBC problem; we as an institution should endeavor to retain this attitude and capability.

Combat Service Support

Perceptions as Reality. As a general comment, and with the exception of food, ammunition and water, the perception at the user unit level was that the overall CSS effort was an abject failure. This was true from the mechanic through the maintenance chief, and to most subordinate commanders. Supply and maintenance personnel as well as commanders and crews, frequently commented that had the conflict gone on a few more days, the force would have ground to a halt. They also inject that had the enemy fought to any degree, all classes of supply, particularly ammunition, would have been critical. Confusion seemed to reign as supply, logistic and maintenance personnel, familiar with "doctrinal" CSS organization, were lost in the "maze" of ad hoc arrangements and the

unfamiliar sub-task organizations of the Combat Service Support Element.

Spare parts seemed to be the focus of the problem as they were frequently not obtainable in a timely manner, if at all. Some units stated their fill rates were as low as 3%. Parts were often issued on a first-come-first-served basis without regard to Marine Corps Integrated Maintenance Management System (MIMMS) procedures. The lack of parts had, at times, serious impact. For example, at least one tank crossed the line of departure with an inoperable fire-control computer. Other vehicles were towed across the LD due to the lack of parts. Regarding secondary repair parts, there were numerous problems with quality control and/or quality assurance. Maintenance personnel at the battalion level were ultimately required to execute unauthorized repair and rebuild (out of their echelon) on these parts. There were no other means to keep vehicles up and serviceable. Cannibalization and selected interchange were routine for the same reasons.

The MEF commander made specific decisions regarding what was to be the focus of CSS effort. It is not surprising that in those classes of CSS the MEF commander consciously decided to de-emphasize based on his conceptualization of the upcoming conflict, were exactly those areas that were most often mentioned as examples of total failure by interviewees. A true crisis of confidence regarding the CSS system arose out of this, a crisis that could have been avoided had an explanation been disseminated.

Fuel. The fuel available for diesel burning vehicles was not Diesel Fuel 2 (DF-2) but rather Jet Petroleum (JP)-5, JP-8, or JetA (JA)-1. The impact this had on armor operations was that tank crews did not have self-generating smoke available for use. Performance of vehicles deployed from CONUS accustomed to burning DF-2 experienced continual problems with power loss, clogged filters, pumps and injectors. The vehicles that came directly from MPF had fewer problems in this area. The M1A1 tanks had no problems using these fuels. Most armored assets experienced significant increases in fuel consumption as compared to what is normal with DF-2.

Maritime Pre-positioning. Generally the MPF concept worked well as it related to armor, but vehicles and equipment sourced from MPF were more often than not lacking in stock list-3 components or had not received the most up-to-date modifications in common use within the FMF. This was particularly true in the case of AAV transmissions and, as previously addressed, the vehicle's weapon station. Frequently notes were found in tool boxes and other containers detailing the fact that required items were missing. Some officers interviewed stated they had cited discrepancies on MPF ships nine months prior (during pre-conflict MPF exercises) to the contingency. These had not been corrected at the time of the SWA off-load.

MPF problems dealt with equipment modernization and how, once off loaded, vehicles and equipment were distributed to the force. In terms of modernization it would make sense to run MPF equipment through maintenance cycles more frequently, increasing the opportunity to update as applicable. If standard procedures do not exist for the distribution of MPF equipment, then a recommendation would be to establish some. If they do, then all things being equal, they should be followed to the greatest degree possible.

Reserves

Commanders within the regular establishment were positive in their comments regarding the integration, training and professionalism of reserve units. In fact the most common comment was that they were as good or at times better than regular units. The team found the reservists to be knowledgeable, dedicated and serious about their business. Reservists tended to be generally older and more mature than regulars, and acknowledged that they enjoyed significantly more unit cohesion than their regular counterparts. The Marines considered themselves to be well-grounded in the basics of their MOSs, but were quick to point out the fact that the weeks and months of training in SWA prior to G-day was essential. Frequently they stated that it was their belief that the unit cohesion and amount of crew, section, platoon and company level training they receive made them better trained and more capable than the regulars. In many cases reservists felt that they conduct more live-fire training than their active-duty counterparts.

Members of the reserve forces did feel that their most significant training shortfall was a lack of combined arms training and that they do not function well in units larger than company/battery. Their explanation for this shortfall is that they drill and train almost exclusively at the company/battery level and have little appreciation for how their unit fits into the larger whole. As a general comment all interviewees who commented on reserves stated that the company/battery level units were effective soon after their arrival in SWA, but battalion staffs were slow in gaining experience and expertise.

Doctrine and Tactics

Maneuver Warfare. Concerted efforts were made by a number of individuals to apply maneuver warfare to the conflict. It was obvious, however, that the institutionalization of the tenets contained within Warfighting, is some distance off. Speed and tempo were often of great concern to some commanders, but to others keeping subordinate units "on line" in the advance seemed paramount. Commanders at all levels led from the front, but at the same time often attempted strict control rather than relying on the initiative of their subordinates. This factor often caused resentment among junior leaders, both officer and enlisted. It was not uncommon to have interviewees state that they were generally unaware of what the next senior commands mission was, let alone two levels up. Mission orders often amounted to something along the lines of "attack in zone to defeat the enemy." This is also the case regarding commander's intent that was often nothing more than to "clear in zone" or "kill the enemy," as opposed to an expression that was designed to convey the "commander's vision."

Penetration to Exploitation. Tactically Desert Storm transitioned almost immediately from penetration to exploitation. Units passed through the various breaches and into the open desert experiencing little of the expected Iraqi resistance. With the exception of a two regiment, dismounted night infiltration through the first of the two mine fields, the GCE applied standard armored and mechanized tactical techniques. The combined antiarmor team concept, LAIs, attack helicopters operating in close cooperation with ground units, and many other concepts worked well and to a degree were validated. The team found that participants at all

$\frac{1}{x} + \frac{1}{y} = \frac{x+y}{xy}$

Summary/Recommendations

Potential Impact of Desert Shield/Desert Storm. The end result of Desert Shield and Desert Storm was an overwhelming victory, but as professionals we should not let victory cloud our impressions or skew valuable lessons, be they positive or negative. In fact historically the tendency of the U.S. military has been in defeat or near defeat to not critique itself, but to turn its back on any lessons that it could learn from, and look for another war to fight. The most recent example of this is of course Viet Nam, when in 1973 we suddenly re-discovered the Soviet threat, and broke out the maps of the Fulda Gap. From the point of view of constructive critique there is perhaps only one situation worse than losing a war, and that's winning one. By winning we tend to automatically conclude that all of the equipment, doctrine, tactics, etc., with which we fought, has been validated.

As made clear early in this analysis the factors that made up the tactical situation in SWA are totally unique, and although we are duty-bound to analyze and evaluate these experiences, we must look at them for what they were. The enemy defeated by the coalition forces was a heavily armed Third World force. The Iraqis may have been the largest in terms of materiel and men under arms, but they presented a World War I defense to a force that prides itself on its capability to fire and maneuver at both the tactical and operational level. The Iraqis were also suffering from a crisis in leadership and morale throughout their military and national structure, a vulnerability exploited by air power, the threat of an amphibious assault in their rear, and two lightning attacks one from the south and a second from the west.

Expeditionary and Amphibious. No matter how one looks at the Marine Corps' future, expeditionary warfare via the amphibious operation is the central focus. The requirement for armor and mechanized forces to operate within the expeditionary and force projection mission are essential. Although none of the armor or antiarmor systems deployed to SWA were tested, the results obviously indicate that all of the MEF's equipment is fundamentally sound. It should be kept in mind for future acquisition strategies, however, that the balance between range and usable range may have been reached or already surpassed in the TOW and M1A1. Even if enhancements to thermal, IR or any other kind of imagery could ensure the gunners could IFF vehicles beyond current limits, the influence of LOS makes the likelihood of acquisition beyond current maximums (4,000 meters) so low that one could question as to whether it would be worth the expense.

The ACE makes the MAGTF not only the world's most unique military organization, but also its most versatile. The commander's ability to shape the battlefield out to the limits of his area of interest, but at the same time focus or mass air power close when the appropriate target and opportunity presents itself, is the essence of flexibility and smart application of combat power. The lesson of Desert Storm is not that the ACE can destroy 10%-20% of the MEF commander's priority targets, or that

it requires even more sophisticated and, in turn, expensive precision guided munitions to kill the rest. The lesson is that air power, even in the ideal conditions enjoyed in the KTO, is not the most efficient destroyer of point targets, even assuming that they can be located. Understanding this, in a conflict where the GCE has not yet been committed, the ACE should not be held in reserve or under employed. In this case the ACE should be directed, as it was in SWA, against any target that is consistent with the commander's guidance.

Americans, and the American military especially, tend to be enamored with technology and seek hardware solutions to every problem. It is where we put our money and most of our effort. What really worked in SWA was the people, and if we continue to invest in this aspect of the force, and not fall victim to an over reliance on technology and a "knee jerk" search for the technological solution, we will be better off in the long run. Again the KTO was unique and extreme in almost every respect, and in a time of fiscal limitations it might not necessarily make sense to chase a potential ground or air capability that may be possible if you throw enough money at it. The lesson of SWA is balanced forces with an emphasis on arriving quickly with the forces trained to fight, and the capability to sustain themselves.

Recommendations

Target Acquisition. The studies referenced in this paper point to the fact that any increase in range, beyond that which the TOW and modern MBT currently enjoy, will provide little added advantage. This is particularly true of any system that requires either the gunner (TOW, Dragon), or system (Advanced Antitank Weapon System-Medium (AAWS-M)), to maintain continuous target track until impact. A second major factor is the issue of fratricide. Requirements and acquisition staffs would be well advised to first consider environment factors, intervisibility percentages, tactics, etc., before dedicating time, effort and money in acquiring weapons or enhancements that provide little advantage, at great expense.

Ground Operations

1. Regardless of how much sense a single fuel policy might appear from a CSS point of view, if it restricts or decreases the tactical or operational capabilities of equipment it should not be implemented. This is particularly true in the case of crew survival.
2. Combine laser and compass capabilities into weapon sights (thermal and day) on tanks, LAVs and TOWs.
3. Improve the Emerson "901" Turret (hammerhead) on the LAV-AT to the point that it can stop and fire without lengthy system deployment and zeroing delays.
4. Retrofit a compass in tanks and AAVs. Currently a crewman must dismount the vehicle and shoot an azimuth with a hand-held compass.
5. Retrofit AAVs with a thermal capability for the driver and gunner. If the AAV is expected to operate in tandem with the M1A1 the

crews must have the same visual and target acquisition capabilities.

6. Consider procurement of DU ordnance for the 25mm gun on the LAV-25. Although still not a reliable tank killer, this ordnance is effective at extended ranges against modern infantry fighting vehicles. This would be particularly important as the MAGTF is likely to be employed in areas of the expeditionary environment in which deployment of heavy armor would not be appropriate, or timely.

7. Develop a simple HMMWV mount for the Dragon. In many regions of the expeditionary environment use of the TOW will be restricted and the Dragon will fill this void.

8. When available, exploit the various studies conducted by the U.S. Army relative to battle damage suffered by like equipment items.

Air Operations

1. Accurate target location and BDA was severely restricted due to the lack of a photo reconnaissance capability within the ACE. The lack of this capability also impacted adversely on all requirements for air photographs throughout the MEF. This is a vital capability lost and must be regained immediately.

2. The 5" "Zuni" WP rocket was the only suitable visual mark for aircraft under control of FAC(A)s. The 2.75" rocket's signature was insufficient for the mission. The Zuni must be retained and in sufficient quantity for this Marine critical requirement.

3. The software and fusing problems experienced with Rockeye must be fixed in order to provide the ACE the flexibility to execute both high and low tactics.

4. JSTARS was deployed to SWA five years prior to its scheduled operational debut (1996). The opinion regarding the system was mixed throughout the MEF. The JSTARS was reportedly extremely effective when working in the U.S. Army's zone of responsibility. This was particularly the case when it data linked in real time directly to the Airborne Warning and Control System (AWACS), that in turn immediately focused air power against Iraqi units operating in the path of the Army's attack. Interoperability with this system is a requirement for future joint battle management, and it should be obvious that the Marine Corps must integrate and gain full access to both JSTARS and AWACS.

5. The Marine Corps requires aviation attack capabilities that can execute both the interdiction as well as close support missions, and do this in a potentially infrastructure austere environment. Certainly a lesson of SWA was the AV8B's ability to generate respectable sortie rates from the decks of amphibious ships which are, after all, forward operating and expeditionary bases. Other lessons, however, were the same aircraft's inability to linger for any reasonable time while FAC(A)s sought out targets, or survive against SA-16s which are increasingly the most prolific low-level missile threat on any battlefield. Although AV8Bs operated from the most forward fixed-wing facility of any CENTCOM aviation unit, and by general comparison this facility was Spartan, it did provide runway and support accommodations.

The development of the A-10 aircraft was an acknowledgment that in order for an aviation platform to have a reasonable chance to acquire and successfully engage armor, it must be able to perform well at low altitudes, at relatively slow air speeds, possess a capability to remain long over the target, and have a direct fire weapon with a realistic hit probability. The A-10 experienced difficulties in SWA with flight restrictions that prevented it from operating at altitudes that ensure its systems maximum effectiveness, but next to the attack helicopter, it was reportedly the most lethal aviation system against armor on the battlefield. Some ACE FAC(A) aircrews, acknowledging some degree of heresy for their comment, stated that the A-10 was worth as many as 10 sections of AV8Bs. The A-10 is not a recommended acquisition, but its capabilities certainly are.

Serious consideration should be directed towards what is the proper mix between the AV8B that provides the Marine Corps tremendous capability in many areas, but falls far short from the perspective of station time, survivability, integration into the close battle, etc., and an aircraft that will fill the void. Modern attack helicopters provide the very capabilities that no high performance aircraft will seemingly ever possess. Rapid refueling and rearming from forward, truly austere and, perhaps most importantly, temporary facilities ashore. Helicopters also guarantee unrivaled availability to the MAGTF commander for use as a separate maneuver element, massing as required in support of the GCE, or in any other way he deems fit.

6. The conflict in SWA was, as discussed above, unique in almost every way. There was an abundance of CENTCOM air power and the convenience of applying this power to targets almost at will. The MEF experienced little in the way of a Iraqi defense, no significant armored counterattacks and no serious threats that would have required the massing of ACE assets. With a lack of those types of targets most suitable for the special characteristics inherent to air power, the ACE was directed against the only available, but also the most difficult of all targets for any aircraft to acquire and engage, the stationary point target.

As a recommendation we must avoid reacting to SWA in such a way that will prepare the MAGTF to fight only in that region at some future date. It would seem, as an example, if the enhancements recommended by many attack pilots to improve the ACE's aircraft against dug-in armor are retrofitted, it will serve to further limit the airframe's capability to provide support. The air offensive was effective in SWA, but not necessarily in the number of specific priority targets it destroyed. It was very successful, however, in the indirect psychological impact it had on the Iraqi. Target destruction was seemingly most efficient, as it has traditionally been with air power, when aircraft caught convoys of trucks or armor on the road or congregated in assembly areas. A new lesson that is also emerging from SWA is the linking of air power to real-time intelligence assets such as JSTARS, AWACS, or position-location radars. In the case of the MEF, linking the ACE to the Q-36 or Q-37 (Tiger Brigade asset) counter-battery radars was highly effective in massing air power on nearly impossible to locate Iraqi artillery batteries.

Fratricide. In the postmortem conducted on this issue, solutions such as IFF devices or more stringent fire control procedures, etc., will be

discussed and decided upon. Many of these will perhaps be effective and some electronic device would seem to make sense. Regarding electronic solutions, however, staffs should consider first how confident aircrews are in the reliability of aircraft IFF devices, before investing too much in this as a possible solution to the friendly fire problem.

In the conclusion of the Leavenworth study two factors are offered up as both the causes and possible solutions to the problem of friendly fire. The first is that since most fratricide (amicicide) incidents are directly related to human error. The study recommends that "the human factors responsible for the occurrence of amicide incidents of all types should receive priority." The second points toward the direction advancing technology has taken as it pertains to military applications. The point made is that "military technology has increased rather than reduced the problem of amicide," and that military machines have surpassed in capability beyond man's ability to safely control them. The study points out that the problem will grow rather than decline, and that advances in safety devices have likely be offset by advances in weapon design and capability.(8)

The solutions are many, but must include force-on-force training with hit indicators and source recorders to develop the situational awareness of both the GCE and ACE. Another obvious solution is to close the gap between human ability and system capability.

NOTES

1. BDM International, Inc., Expeditionary Intelligence Study 1-89 Volume II (Hampton [1990]).
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6. BDM International, Inc., p. II-22-1
7. Charles R. Shrader, Amicicide: The Problem of Friendly Fire in Modern War (Leavenworth: Combat Studies Institute, [1982]), p. 105.
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GLOSSARY

AAA.....	Anti-Aircraft Artillery
AAV.....	Assault Amphibion Vehicle
AAWS-M.....	Advanced Antitank Weapon System-Medium
ACE.....	Aviation Combat Element
AMSAA.....	U.S. Army Materiel Systems Analyses Activity
AGL.....	Above Ground Level
ATGM.....	Antitank Guided Missile
AWACS.....	Airborne Warning and Control System
BAT.....	Battlefield Assessment Team
BDA.....	Bomb Damage Assessment
BRL.....	U.S. Army Ballistic Research Laboratory
BZO.....	Battle Sight Zero
CAS.....	Close Air Support
CE.....	Chemical Energy
CENTCOM.....	Central Command
CIFS.....	Close In Fire Support
CINC.....	Commander-in-Chief
CONUS.....	Continental United States
CSS.....	Combat Service Support
CSSE.....	Combat Service Support Element
CVC.....	Combat Vehicle Crewman
C3.....	Command, Control and Communication
DF.....	Direction Find
DF-2.....	Diesel Fuel 2
DU.....	Depleted Uranium
EDWS.....	Electric Drive Weapon System
EPW.....	Enemy Prisoner of War
EW.....	Electronic Warfare
FAC(A).....	Forward Air Controller-Airborne
FLIR.....	Forward Looking Infrared
FMF.....	Fleet Marine Force
FSCL.....	Fire Support Coordination Line
FSTC.....	Foreign Science Technology Center
GCE.....	Ground Combat Element
GPS.....	Global Positioning System
HE.....	High Explosive
HF.....	High Frequency
HMMWV.....	High Mobility Multi-Wheeled Vehicle
IFF.....	Identification Friend-or-Foe
INS.....	Inertial Navigation System
IPB.....	Intelligence Preparation of the Battlefield
IR.....	Infrared
JMEM.....	Joint Munition Effects Manual
JP.....	Jet Petroleum
JSTARS.....	Joint Surveillance Target Attack Radar System
KTO.....	Kuwait Theater of Operations
KY.....	Crypto
LAAW.....	Light Antiarmor/Assault Weapon
LAI.....	Light-Armored Infantry
LASER.....	Light Amplification by Stimulated Emission of Radiation
LAV.....	Light-Armored Vehicle
LAV-AT.....	Light-Armored Vehicle-Antitank
LOS.....	Line-of-Sight
MAGTF.....	Marine Air-Ground Task Force

• MAWTS.....Marine Aviation Weapons and Tactics Squadron
, MBT.....Main Battle Tank
MEDEVAC.....Medical Evacuation
MEF.....Marine Expeditionary Force
MIMMS.....Marine Corps Integrated Maintenance Management System
MOS.....Military Occupational Specialty
MPF.....Maritime Pre-Positioning Force
NBC.....Nuclear, Biological, Chemical
PLRS.....Position-Location Reporting System
SA/SAM.....Surface-to-Air Missile
SMAW.....Shoulder-Launched Multi-Purpose Assault Weapon
SWA.....South-West Asia
TOW.....Tube-Launched, Optically Tracked, Wire-Guided
UGWS.....Up-Gunned Weapon Station
WP.....White Phosphorous

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APPENDIX

The Battlefield Assessment Team collected over 400 gunnery survey forms each of which represents one antiarmor engagement by either a tank, an LAV, ATGM, or an antiarmor rocket. Many of the respondents in fact fired more than once, but each engagement was considered individually. The tables within this appendix are the result of statistical analysis conducted by Mr. George Akst, an analyst at The Center for Naval Analyses, utilizing the data made available to him by the BAT.

The method(s) of interview fell into two general categories. The first was when the individual who actually fired the weapon was asked to describe in his own words the details of the engagement. Once satisfied that all relevant information had been collected, other individuals, crew members, etc., who were also involved, were queried as to their perspectives. The second, and less common interview technique, was small group interviews.

I believe there is a high degree of truth to the interviews for at least two primary reasons. The first is that the interviews were conducted reasonably close to the point in time that the engagements took place. The second, that interviewees were frequently willing to point out their own perceived shortfalls in terms of fear, fatigue, confusion, poor range estimation, improper employment of the system, crew problems, misses as well as hits, etc.

The specific criterion for defining a mobility, crew or catastrophic kill was established by the team prior to commencing the survey. Individuals interviewed were not informed of what the criterion was, but simply described the results of their engagements.

In the case of a catastrophic event the gunner had to report that the target, at a minimum, was hit and burned in such a way that the crew compartment was completely involved. Due in large measure to the way ammunition was stored within the Iraqi tanks, any penetration of the crew compartment caused this type of fire. In most cases the vehicles immediately exploded after being hit, frequently with the turret flying off with secondary explosions and fire observed.

A crew kill was credited if the target was moving and stopped when hit with no obvious explosions or fire, and no exiting of the vehicle by its crew was observed.

A mobility kill occurred when the target was hit and the result could not be considered catastrophic. In some cases the crews could be observed exiting the target.