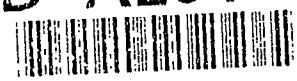

STUDY PROJECT

SCATTERABLE MUNITIONS = UNEXPLODED ORDNANCE (UXO) = FRATRICIDE

BY

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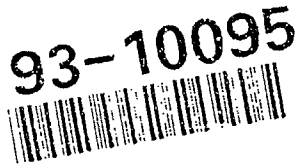
U.S. ARMY WAR COLLEGE, CARLISLE BARRACKS, PA 17013-5050



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High technology foreign and U.S. munitions that dispense numerous submunitions and area denial ordnance have led to the proliferation of unexploded ordnance (UXO) throughout the modern battlefield. The inevitable by-product of scatterable munitions is unexploded ordnance which if not properly reported, recorded, marked or eliminated, will result in fratricide levels that have been unprecedented in past wars. A review of the quantity of scatterable mines and submunitions used during Desert Shield/Desert Storm and their effects will be presented. Additionally, examples of the use of submunitions and resulting unexploded ordnance incidents involving U.S. soldiers will be reviewed. The massive post war clean-up of UXO in the Kuwait theater will also be addressed. Current and future doctrine, training, leader development, organizations and materiel focus on soldiers (DTLOMS) will be analyzed to support interim changes and recommendations to prevent or limit future fratricide incidents involving unexploded ordnance.

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SCATTERABLE MUNITIONS = UNEXPLODED ORDNANCE (UXO) = FRATRICIDE

AN INDIVIDUAL STUDY PROJECT

by

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ABSTRACT

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INTRODUCTION

> A convoy of light armored vehicles sat in the desert with their engines idling just outside Kuwait City. Several marines got out to look at the charred remains of Iraqi tanks and trucks when there was a loud report and cry of pain. A corporal, standing on the edge of the road, had stepped on a stray piece of munition and blown off part of his foot. As the medics helped the man to a stretcher, the marines moved back inside their vehicles, each aware that much of the Kuwaiti desert is a death trap, filled with Iraqi mines, unexploded munitions and cluster bombs that were dropped by the allies but never went off.[1]

This is just one example of the 94 separate incidents involving Unexploded Ordnance (UXO) reported during and immediately after Operation Desert Storm. These 94 incidents equate to 104 injuries and 30 deaths.[2] Published reports say at least 19 U.S. soldiers, about 10 percent of all those killed during the Gulf War, were killed by cluster-type bomblets used by the Army and the Air Force.[3] Hundreds of civilians were also killed or wounded by these bomblets. With the inordinate number of bomblets dropped in Iraq, thousands will become victims in future years. "Since the end of the war, more than 2,000 Kuwaitis have been injured from bombs and munitions, and most of these casualties have been children." [4]

High technology foreign and U.S. munitions that dispense numerous mines, submunitions and area denial ordnance have led to the proliferation of unexploded ordnance (UXO) throughout the modern battlefield. "The inevitable by-product of these mines and submunitions is unexploded ordnance which if not properly recorded, marked or eliminated, will result in fratricide levels that have been unprecedented in past wars."[5]

This paper will address the issue that fratricide caused by

the proliferation of scatterable mines, submunitions and unexploded ordnance can be reduced drastically in future conflicts. The underlying thesis of this paper is that the U.S. military and its allies must pursue changes in doctrine, training and technology to limit future fratricide involving soldiers, civilians and post war battlefield clean-up personnel.

This issue will be addressed by briefly discussing historical examples of unexploded ordnance in conflicts prior to Desert Storm. A detailed review of the quantity of mines and submunitions used during Desert Shield/Desert Storm and their effects will be presented. Examples of the use of submunitions and resulting unexploded ordnance incidents involving U.S. soldiers will be reviewed. The massive post war clean-up of unexploded ordnance in the Kuwait theater will be addressed. Finally, an analysis of this issue will be done using the Training and Doctrine Command's modernized Concept Based Requirements System (CBRS) format. Current and future doctrine, training, leader development, organizations and materiel focus on soldiers (DTLOMS) will be analyzed to support interim changes and recommendations to prevent or limit future fratricide incidents involving unexploded ordnance.

HISTORY OF SUBMUNITIONS

The idea of using explosive submunitions often referred to as bomblets, submissiles, grenades or subshells dates back centuries.

Civil War grape shot and shrapnel bombs were early examples. Cluster bombs that resemble today's concept were employed by both the Allied commands and Germany during WWII. The Soviets were apparently the first to employ bomblets in aircraft dispensed cluster bombs against German armor on the eastern front in 1943.[6] Germany followed with their own bomblet technology.

In the past, Air Force bombs and artillery munitions were predominately melt-poured steel, trinitrotoluene (TNT) filled, unitary designed to produce fragmentation explosions that inflicted casualties. Battles of WWI and WWII were fought using high explosive shells and hand emplaced land mines. They produced a deadly burst when exploded, but lethality fell off very sharply the farther you happened to be from the point of detonation.

Bombs, mines and artillery rounds designed to explode on impact or contact often fail to detonate. If not encountered by man or machine the munitions remain on the battlefield for hours, days, weeks or years. These mines, bombs, and artillery rounds become what is commonly referred to as Unexploded Ordnance.

HISTORICAL EXAMPLES OF UNEXPLODED ORDNANCE

Examples of unexploded ordnance from WWI can be found at Verdun, France. Uncleared minefields from WWII can still be found near Tobruk in Libya. Unexploded mines and bombs continue to be found in both Germany and England. Mines and bombs are still in

place in Korea. Old French mines and U.S. unexploded ordnance can still be found in large quantities in both Vietnam and Cambodia. Recently we have seen a proliferation in the use of landmines and resulting unexploded ordnance in conflicts such as the 1973 Arab-Israeli War, the Falkland Islands, Afghanistan and most recently Operation Desert Storm.

The 1973 Arab-Israeli post war clean-up of the Suez Canal involved military Explosive Ordnance Disposal (EOD) teams from several countries to include the United States. During the 1974 clearance operations the Egyptians destroyed in excess of 680,000 mines and 60,000 pieces of ordnance. Approximately 60 personnel were killed in the clean-up operation.[7] Men of the British Royal Engineers had a long and complicated task of clearing mines, ammunition and other unexploded ordnance in the Falklands after the British victory. Since 1982 they have destroyed no less than 2.5 million items.[8]

During the Soviet war in Afghanistan both the Soviet and Kabul government forces, facing a predominantly dismounted enemy, employed both hand-emplaced and scatterable antipersonnel minefields of Warsaw Pact manufacture. Millions of these mines were employed with few if any records of their location. As a result, after the Soviet withdrawal, a United Nations program called Operation Salam was developed to clear the mines that have inhibited the resettlement of over five million Afghan refugees.

Thousands of citizens have been killed or injured by the millions of mines, submunitions and unexploded ordnance scattered throughout Afghanistan.[9]

SUBMUNITIONS, UNEXPLODED ORDNANCE, MINES IN SUPPORT OF DESERT STORM

A submunition is any piece of explosive ordnance carried in a larger container, called a dispenser. The dispenser, depending on the type, fires from a howitzer, drops from an aircraft or fires as a missile or rocket. These submunitions are often referred to as cluster bombs. At a predetermined altitude, the dispenser opens, and the submunitions scatter. Types of submunitions vary from simple, fused devices that detonate on impact to highly sophisticated devices that wait for a person or vehicle to pass before detonating. They come in all sizes, from golf ball size to a beer "pony keg" with a six-foot spike sticking out.[10] This paper will review both artillery and air force delivered submunitions.

We will begin our look at submunitions by first looking at artillery tube and rocket fired munitions. Today's artillery fires rounds and rockets loaded with not only high explosive warheads but also loaded with submunitions known as improved conventional munitions (ICMs). Except for testing purposes, these ICMs were seldom fired prior to the Gulf War to limit duds or unexploded ordnance on training ranges.

ARTILLERY DELIVERED

IMPROVED CONVENTIONAL MUNITIONS

The current state of the art for 155 mm and 8-inch artillery projectiles used by the U.S. Army, Marine and coalition forces is a cargo carrying projectile that delivers a quantity of individual submunitions or grenades that possess both anti-personnel (AP) fragmentation and a metal penetration or anti-tank (AT) capability. This type, with dual purposes is called a Dual Purpose Improved Conventional Munition (DPICM). These weapons were developed and produced after the Vietnam War beginning in the early 1970's. The two different U.S. 155 mm artillery projectiles carry a total of 72 and 88 dual purpose grenades. The U.S. 8-inch artillery projectile carries a cargo of 180 each dual purpose grenades.[11]

After a projectile is fired and reaches the target area, the submunitions are released from the dispenser approximately 500 meters above the target. The submunitions are designed to self arm their fuses before impact in a vertical orientation to allow the firing pin to initiate the detonator. If the grenade tumbles or impacts at angles of inclination of 15 degrees or less to horizontal, it can result in the failure to detonate, especially in snow, mud or deep sand.[12] All of the DPICM submunitions are designed to detonate upon impact.

The dud rate for howitzer ammunition tested after each production run is believed to be 2 percent.[13] The maximum allowable production dud rate is 5 percent.[14] The dud rate for

DPICM experienced during Desert Storm was not determined but is believed to be within 5 percent. An example of artillery fire would be one volley for a 24 gun 155mm battalion. Using a 5 percent dud rate, this 24 round volley would equate to 106 unexploded DPICM grenades in a target footprint area of 150 meters by 200 meters.

In addition to artillery tube fired DPICM projectiles, 17,286 Multiple Launched Rockets were employed during Desert Storm. The Multiple Launched Rocket System (MLRS) fires rockets loaded with 644 dual purpose grenades in each rocket. The normal engagement requires a minimum of 6 rockets or dispensers to be fired into a target area, for a total of 3,864 grenades. Using a 5 percent dud rate this would equal 193 unexploded grenades in a target footprint area of 200 x 300 meters. The MLRS grenades are a variant of the dual purpose grenades dispensed by tube artillery. The dud rate for MLRS is somewhat higher than the tube fired submunitions but production dud rate is still limited to 5 percent.[15] Two production runs of an undetermined amount have been waived to 7 percent.[16] During the Gulf War, a total of 2,881 six rocket packs were fired, employing a total of over 11,132,184 bomblets.[17] At a 5 percent dud rate, this would leave over one half million dual purpose MLRS unexploded grenades scattered in Kuwait and Iraq.

Since fire support elements are not required to document where rounds impact, no one knows where the MLRS rockets dispensed the 11 million bomblets. Operation Desert Storm employment of DPICM involved the saturation of targets with massed artillery and MLRS

rocket fires. These fires would often equal 12,000 plus submunitions per target.[18] A 5 percent dud rate would leave 600 plus unexploded grenades in the 200 meter by 300 meter target area.

To make matters worse, the worldwide use of ICM has rapidly increased in recent years. An example of this is that a typical U.S. Army field artillery unit's basic load is now approximately 85 percent ICM.[19] Of note, the MLRS only fires DPICM and other services and our allies also have similar DPICM capabilities. Even though Iraq did not use ICMs, they along with future opposing forces will have access to ICMs and are likely to use them in a similar manner against U.S. forces. The worldwide proliferation of artillery submunitions is taking place in both friendly and potential threat nations. U.S. forces can and must be prepared to deal with both friendly and enemy produced submunition UXOs.

To date, the U.S. has manufactured well over three-quarter million DPICM grenades, with the majority still in the inventory, despite their heavy use in the Gulf War.[20] "Preliminary evidence suggests that the number of DPICM grenades delivered onto the battlefield in Kuwait may have exceeded 30 million units."[21] The real question is what percent of these DPICMs became unexploded ordnance. Figure I reflects how many DPICMs were used during Desert Storm and the estimated amount of unexploded ordnance.

AIR DELIVERED BOMBS / CLUSTER BOMB UNITS (CBU) / COMBINED EFFECTS MUNITIONS

The second major source of unexploded ordnance was from air

delivered weapons of the coalition forces during the six week air campaign. Reports from Kuwait indicate that around one third of these submunitions failed due to landing in soft sand.[22] "During the war, U.S. jets pounded Iraqi anti-aircraft positions with cluster bomb units (CBUs) called baseballs and rockeyes. Millions of them never exploded, and today they litter the desert like confetti on a convention floor."[23]

Cluster bomb units (CBUs) are dispensers loaded with submunitions and may remain attached to the aircraft or released as a free-fall unit. Dispensers that remain attached to the aircraft dispense the submunition by ejection through the bottom of the dispenser. Dispensers that are released as free-fall units are designed with clamshell longitudinal sections that blow apart at a predetermined time after release, or at a given altitude to release the submunitions inside. These submunitions are bomblets or mines designed for use against such targets as light material, personnel, or armor.[24]

The B-52s' battlefield air interdiction targets during Desert Storm were usually armor or artillery units, but often supply facilities and troop concentrations and radar sites were bombed. As the ground war approached, these weapons were used with devastating effect to thin out Iraqi troop strength.[25]
During one night early in the war, nine B-52s conducted near simultaneous cluster-bomb attacks against three major Iraqi radar facilities defending the western approaches to Baghdad. "The explosions from 88,000 orange-size bomblets shredded and silenced

each site."[26] An estimated 4,000 unexploded bomblets were also left at each of these radar sites.

Several types of Air Force cluster bombs were used in the Kuwait theater. Approximately 17,800 CBU 52, CBU 58, and CBU 71 cluster bombs were dropped before and during the conflict.[27] The CBU 52 cluster bomb is loaded with 220 bomblets that resemble metal softballs. The CBU 58 and CBU 71 cluster bombs contain 650 bomblets that are somewhat smaller and resemble baseballs. The CBU 52 and CBU 58 are designed to explode upon impact. The 650 bomblets of the CBU 71 detonate at random times after impact.[28] Over 9 million of these bomblets were dropped in Kuwait and Iraq.[29] Production acceptance dud rates are not available. However, a 5 percent dud rate similar to the Army's DPICM can be expected. Figure I lists the amount of bomblets dropped by the U.S. Air Force and the estimated number of submunitions that resulted in UXOs.

A second type of cluster bomb called a combined effects munition is the CBU 87. Each CBU 87 dispenser contains 202 BLU-97 bomblets.[30] Each bomblet is the size of a can of spray paint with a small parachute coming out the back. Despite their small size, 2 inches in diameter and 10 inches in length, each bomblet's shaped charge can defeat the top armor of any tank.[31] During the Gulf War, the U.S. Air Force dropped 10,035 CBU 87 dispensers consisting of 2,027,070 BLU-97 bomblets.[32] Each of these submunitions bomblets were designed to explode upon impact. However, due to delivery methods and the soft sand, many of them failed to detonate. (See Figure I)

The BLU-97 is initiated by an extremely sensitive fuse and duds should not be moved. Unfortunately the mishandling of this type of unexploded ordnance resulted in the death of 7 U.S. combat engineers while clearing an Iraqi airfield that our Air Force had put out of commission during the Gulf War. On 26 February 1991 Company A of the 27th Engineer Battalion had the mission to clear the 9,000 foot runway at As Salam to a width of 300 meters. The airfield was to be used by U.S. C-130 aircraft to transfer wounded personnel from forward areas of operation tc hospitals in Saudi Arabia. For some unknown reason, a pile of BLU-97 UXOs exploded unexpectedly killing the company commander, platoon leader, platoon sergeant and four other enlisted soldiers. This tragedy occurred during daylight killing experienced engineer soldiers who were doing their jobs after careful planning and rehearsal. The battalion commander indicated that the clearance mission was extremely difficult because every square meter on the airfield appeared to have one or two unexploded bomblets.[33]

A third Air Force delivered submunition and the largest dud producing bomb during Desert Storm is the MK-20 Rockeye cluster bomb. The Rockeye is an anti-tank (AT) cluster bomb dispenser with 247 bomblets. Each bomblet is only 2 inches in diameter, 13 inches long and weighs 1 pound.[34]

The U.S. dropped 5,345 Air Force and 6,804 Navy MK 20 Rockeyes or CBU 59 equivalents in the Kuwait and Iraq.[35] This resulted in an average of nearly 6 million submunitions or bomblets being dropped. The percentage of Rockeye bomb submunitions that failed

to detonate on impact has been reported as being very high compared to the dud rate of DPICM failures.[36] The International Defense Review magazine was told, "A 30-40 percent failure rate for U.S. Rockeyes has created a major problem over large areas of Kuwait."[37] After a personal visit to Kuwait in November 1992, to observe the UXO clearing operations, the Project Manager for U.S. Mines and Countermines indicated that the Rockeye duds were predominant and had to be very high compared to other submunitions.[38]

During the first four days of the air campaign, British Tornado aircraft flew 50 sorties on Iraqi airfields. Each of these sorties dropped 490 small bomblets out of their dispensing pods. The bomblets were a mix of 60 runway cratering charges and 430 area denial mines that detonate at random intervals during the days that followed. This resulted in 24,500 submunitions being dropped on Iraqi airfields.[39] Unexploded bomblets certainly resulted. However, British sources will not say what percentage of duds can be expected.

SCATTERABLE MINES

Today's scatterable mines are used to create "instant minefields" where and when they are required. The increased lethality of offensive weapons and accelerating tempo of operations require an advanced generation of land mines to be used to support both defensive and offensive operations. The U.S. Army's Family of Scatterable Mines (FASCAM) offers a selection of mines and delivery

systems to meet the wide spectrum of tactical situations in both defensive and offensive combat operations.[40] The FASCAM systems discussed here include both anti-tank and anti-personnel mines which can be delivered by artillery, aircraft, wheeled and track vehicles.

The GATOR mine system is an air-delivered scatterable system used by both the U.S. Air Force and Navy. The weapon system consists of both anti-tank and anti-personnel mines. GATOR is a cluster weapon system for deep interdiction missions and airfield denial. It can be delivered from various aircraft at altitudes of 250 to 5,000 feet at speed up to 800 knots. The average area covered is approximately 200 by 650 meters.[41]

The Air Force version contains 94 mines (72 ATs and 22 APs) per dispenser. The Navy's system contains (45 ATs and 15 APs) per dispenser. A 650 meter minefield with a depth of 200 meters requires 6 Air Force bombs in one sortie to drop a total of 432 AT and 132 AP submunitions.[42] For larger areas, multiple sorties can be flown to gain greater coverage. All Gator submunition mines are capable of self destruction. The self destruct times (4 hours, 48 hours or 15 days) can be selected when the dispensers are mounted to the delivery aircraft. "The probability of a live mine existing past its self destruct time is 1 in 1000."[43]

During Operation Desert Shield/Storm, U.S. Air Force dropped 1,105 GATOR dispensers and U.S. Naval and Marine aircraft dropped a total of 215 GATOR dispensers. The total GATOR submunitions dropped during Desert Shield/Desert Storm equals 92,460.[44] Due to

the low probability of duds, the GATOR mine should only be considered a UXO until it has exceeded its self destruct time. However, it is important that maneuver units operating near these minefields be notified where they are located and when the self destruct times will occur. There is no indication of any casualties resulting from GATOR UXO.

There are currently only two types of artillery fired scatterable mines and both are normally used together. The Remote Anti-Armor Mine (RAAM) is delivered from a 155 howitzer projectile. The projectile emplaces 9 anti-tank (AT) RAAMs. These rounds contain magnetically induced fuses which activate the mines when a tank passes within lethal distance.[45]

The Area Denial Artillery Munition (ADAM) is an anti-personnel (AP) mine often used to prevent or disrupt the removal of RAAM mines. A fully loaded 155 mm projectile carries 36 ADAM mines. After the 36 ADAM mines come to rest, each mine simultaneously deploys seven tripwires to complete its arming sequence. A standard 1000 meter front minefield is normally fired by a 6 gun battery of 155 mm howitzers. A total of 648 ADAM mines and 432 RAAM mines can be delivered in approximately five minutes from a maximum distance of 17.5 kilometers away.[46]

Both the ADAM and RAAM submunitions have self-destruct mechanisms built in and set during factory productions. The spin or acceleration of the munition and an electronic signal signals the mine to self-destruct at 4 hours or 48 hours depending upon the fuse used. The probability of a live mine existing past its self-

destruct time is also 1 in 1,000. Mines that remain are duds. They are inoperative due to battery rundown, but should be treated as unexploded ordnance.[47] U.S. forces did not use the RAAM or ADAM munitions during Operation Desert Shield/Desert Storm.[48]

The remaining four U.S. scatterable FASCAM mine systems are all delivered by systems assigned to combat engineer ground units. The Ground Emplaced Mine Scattering System (GEMSS), the Flipper, the Volcano system and the Modular Pack Mine System (MOPMS) are currently all dispensed from moving engineer vehicles or from a fixed point on the ground.

Planning and employment of minefields using these systems are done by trained combat engineers. For these ground vehicle mounted systems, mines are dispensed 25 to 60 meters from the vehicle at ground speeds of 5 to 55 mph. All submunitions dispensed from each system have self-destruct times ranging from 4 hours to 15 days. These times are set in the field by combat engineers just prior to emplacement.[49] The GEMSS and Flipper systems are being replaced by the new Volcano system that can deliver up to 960 submunitions (all with self-destruct capability) to emplace a 320 meter by 555 meter minefield by using multiple strips.

The ground emplaced scatterable mine systems are all well planned, cited, recorded and reported to proper authorities by combat engineer units. The careful employment, marking and recording limit the chances of fratricide of U.S. personnel. With the reliable self destruct features of the U.S. scatterable mines, the UXO potential is extremely limited. As long as existing

doctrine and procedures are followed, scatterable mines will result in limited UXOs and fratricide.

THE EFFECTS OF UXO DURING DESERT STORM

The large amount of unexploded ordnance found in Kuwait and Iraq caught both U.S. and coalition forces by surprise. Since the proliferation of submunitons and scatterable mines really began after the U.S. involvement in Vietnam, U.S. forces had little experience in maneuvering through large areas of unexploded scatterable munitions. As a result, we sustained a number of casualties among our soldiers, allies and civilians. Of the 94 Desert Storm incidents involving unexploded ordnance, 33 involved the improper handling of munitions.[50] Of the 33 incidents 18 of those involved improved conventional munitions (ICMs).[51] Army interviews with 204 soldiers injured in the war reveal that 42 percent were wounded by scatterable submunitions, bomblets, and shrapnel from munitions and similar explosives.[52]

The number of submunitions encountered by coalition units was not expected. The amount of unexploded ordnance could not be determined during or after the war. The 5 percent dud rate is only an estimate based upon the project manager's estimate from production tests and his observations during his visit to Kuwait in November 1992. In some cases, such as Rockeye CBUs, the dud rate was greater than the 5 percent indicated.

Figure I lists only the amount of scatterable type munitions.

An additional undetermined number of non-scatterable artillery rounds and bombs were fired and dropped which also resulted in unexploded ordnance. During Desert Storm, U.S. and coalition forces were killed and wounded as they maneuvered over areas that had been fired into and bombed by our supporting artillery and battlefield interdiction. Our DPICMs, CBUs and GATORs littered the battlefield and in fact became minefields.

The locations where aircraft and artillery had dropped vast quantities of submunitions during interdiction missions were seldom passed to U.S. or coalition forces because they were deep missions well beyond the Fire Support Coordination Line (FSCL). These locations of UXO "footprints" (areas of possible UXO concentration) were not tracked, and never passed to mobility planners. UXO confirmation information was only available when reconnaissance units happened upon CBUs and DPICMs.[53]

With the battle tempo and combat operations covering such great distance during a short period of time, many units found themselves in areas that were saturated with submunitions. Vehicle and track operators drove into areas, during daylight and night operations, not knowing UXO were scattered on the ground. This often caused blown tires and other vehicle damage and casualties of many exposed personnel within blast range. The transfer or sharing of UXO footprints is not currently in our Joint or Service doctrine. Doctrine and proposed changes will be discussed later.

Many units and individuals who were not part of the lead elements of the combined arms team did not recognize the various

submunitions that littered the battlefield. Adequate training in the identification of unexploded ordnance was not taught during initial entry or collective training prior to the ground assault. Training aids, such as inert devices, booklets and posters, were not available until after the cease fire.[54] The following actual incidents are examples of UXO casualties.

Three soldiers died when a softball sized item (a cluster bomb submunition) they were playing catch with detonated. Other casualties occurred when a soldier found a piece of metal roughly the size of a spool of thread with a white ribbon on top. He was spinning it around by the ribbon. The MLRS submunition detonated, taking his life and the life of a person nearby. In another incident, a soldier found several golf ball sized items. After putting them in the back of his vehicle, he drove about one mile before the souvenirs took his life. After the war ended, four mechanics from a U.S. armor battalion were examining a piece of ordnance they had picked up. No one knows what it was, because none of them lived. They had survived combat, but not their own carelessness.[55]

On the last day of conflict just before the cease fire, members of a platoon of the 142nd Medical Company of the Connecticut Guard also became victims. In an unsecured area on the Iraq-Kuwait border, during a refueling stop several members of the unit including a field grade platoon leader, physicians, NCOs and enlisted specialists collected what they thought were spent parachute flares. Several were observed hanging the submunitions

from their ears and fingers.[56]

Seven hours later one person was killed and three others were injured when their vehicle exploded by what they thought was a landmine or enemy fire. Believing they were under attack members jumped out of their vehicles and during a search for the enemy, less than a minute later, an explosion mortally wounded one specialist and injured a British soldier. It was not until five days later when a third explosion struck the 142nd back in Saudi Arabia, injuring three soldiers, that the unit realized that unexploded ordnance was the actual cause of all three explosions. Due to a lack of training and leadership, the souvenir bomblets had killed two and injured seven others.[57]

The amount of UXO overwhelmed Explosive Ordnance Disposal (EOD) units. EOD teams were not available in adequate numbers to clear large areas and the hundreds of thousands of UXOs. Maneuver units who had supporting combat engineers tasked them to mark, breach and clear large areas of U.S. and coalition submunitons.[58] The limited EOD assets and combat engineers will be addressed in proposed organizational changes.

UNEXPLODED ORDNANCE:
THE CLEAN-UP OF KUWAIT

Various instances of units encountering unexploded ordnance both during and after the war have been discussed. We have no idea

how many Iraq and coalition mines, bombs, submunitions, and other munitions were used during the conflict. As discussed during the historical sections of this paper, we have always had a significant amount of unexploded ordnance left after every conflict. However, with the proliferation in the use of submunitions produced since 1970 the numbers are much worse. For the first time, millions of mines, missiles and unexploded bombs and bomblets were still visible after the war ended because of the barren desert terrain. Even with the shifting sands, it was clear that many areas were saturated with UXO. The vast areas of soft sandy soil contributed to submunitions not detonating upon impact and certainly contributed to an increase in the amount of UXOs.

Kuwait is the first country that has decided to immediately clear its battlefields of all bunkers, destroyed vehicles, and UXOs to return the land to its natural pre-conflict state. Kuwait, a country about the size of New Jersey, will spend over a billion dollars to clear its deserts of these hazards. Millions of unexploded munitions from 30 countries littered it at the end of the war.[59] It is by far the most ordnance ever left on a battlefield.

Not only did UXO injure and kill coalition and enemy soldiers, it is still killing. It is killing Kuwaiti civilians, desert nomads, soldiers along with civilian contractors from the U.S., France and Britain. "About 100 workers have been killed or maimed on the job and the job is far from over. Most of the casualties

have come from the Egyptian, Pakistani and Bangladesh sectors, which are being cleared by their respective armies."[60]

The Kuwaiti government had been negotiating with European companies concerning the Iraqi mines and ordnance placed in its country since October 1990, three months before the air campaign began. Detailed discussions were underway by March 1991, immediately after the cease fire, to divide the country into six "national" sectors for contract EOD clean-up. Pakistan, Bangladesh and Egypt have the area in northern Kuwait that borders with Iraq. France, the U.S. and the United Kingdom have sectors along the Kuwait-Saudi border. The British cleared Kuwait City first followed by lanes to the oil well heads to put out well fires and get oil back into production. Since last summer the six "national" sectors have been slowly cleared.[61]

The U.S. contracted sector was awarded to Conventional Munitions Systems of Tampa, Florida. This $134 million clean-up contract was negotiated directly with the Kuwaiti government under no supervision or advice by the U.S. government.[62] Unfortunately, the U.S. intelligence community did not provide captured Iraqi minefield maps or air delivered munition data. Currently most of the contractors are keeping accurate records of where and what was found and destroyed. However, the U.S. military has no representation or agreement to gain lessons learned from the clean-up operations. With six separate clean-up operations, and no record of how many duds were detonated or destroyed before the coalition forces departed, we will never know how much UXO remained

in Kuwait. Fortunately, no Iraqi submunitions appeared to have been used against U.S. or coalition forces.[63] This would have drastically increased the UXO rate. This clean-up effort is limited to the country of Kuwait. There is no information on Iraqi attempts to clear UXO's within their country.

PROPOSED CHANGES / RECOMMENDATIONS

DOCTRINE

As improved conventional munitions, cluster bombs and scatterable mines continue to proliferate worldwide, we must review our doctrine of how we will deal with these submunitions on future battlefields. The following six doctrinal areas must be addressed:

1. Planning / Targeting: Joint doctrine involving the targeting and employment of CBUs, DPICM and scatterable mines must be written. All branches of U.S. services as well as coalition partners must consider the effects of dud or UXO submunitions planned and executed at the theater, corps and division levels. The Joint Force Commander (JFC) must require these considerations be addressed by his Joint Force Air Component Commander (JFACC) and his Land and Naval Component Commanders. Target planning must consider future ground maneuver and the effects that UXO submunitions will have on future operations. The "footprint" (location, type and amount) of all CBU, DPICM and scatterable mines must be provided to the Land Component Commander (LCC). This

information must be entered into an automated data base that corps and divisional planners and maneuver units can review when planning and executing missions. Current Joint and Army doctrine does not address UXOs. Joint publications, Training and Doctrine Command (TRADOC) pamphlets, Field Manuals and "How to Fight" manuals must address the UXO problem and how units must maneuver and deal with the residual submunitions.

2. Reporting: Theater, corps and division headquarters must have standard UXO reporting procedures. The reporting and use of submunitions during air interdiction beyond the FSCL must be recorded by the Tactical Air Component Command (TACC) and passed to the Battlefield Control Element (BCE). This information must be passed to the corps fire support element (FSE) for dissemination to the maneuver units. Within the FSCL, the FSE in each corps and division headquarters must report the use of DPICM to affected maneuver units. All units encountering UXO during combat operations must send a simple scatterable minefield report or UXO spot report. A nine line UXO spot report similar to the NBC report has been developed recently and is included in the Soldier's Common Task 093-403-5030. The report will allow the sender to recommend a priority on the UXO hazard of "Immediate", "Indirect", "Minor" or "No Threat."[64] Follow on combat forces, CS and CSS elements need to know where, what type, how much and how the area was marked, breached or bypassed.

3. Dissemination of Information: The information recorded must be disseminated to other elements that may maneuver into the

area of UXOs. Levels or degree of the hazard, whether an area was marked or breached, cleared or can be bypassed must be disseminated.

4. Prediction: Air Force and Navy CBU and Artillery DPICM "footprint" information must be made available to mobility planners during the intelligence preparation of the battlefield (IPB) process. Planners must know the amount of munitions delivered and dud rates when estimating UXO concentrations. They must include the gathering of UXO information in reconnaissance plans to do their estimates in predicting the risks involved when maneuvering through areas saturated with UXO. This information can be managed by the Army Battlefield Control Element (BCE) in the JFACC and passed to affected coalition corps. Corps and division FSE computer systems would add the artillery submunition footprints to a data base. Based upon the type and amount of submunition reportedly fired into an area, a maneuver commander could predict friendly UXO concentrations and declare the area a restricted maneuver area to mounted armored vehicles only. With battle command and control systems that are being developed, this could easily be included.

5. Marking: Hand or mechanically emplaced mines are clearly marked, recorded, and reported by combat engineers. However, scatterable CBUs, GATOR and DPICMs are not marked when employed since they are suppose to detonate upon impact or at a preset time. When the first unit that comes in contact with an enemy or friendly minefield or scattered UXO, there should be a standard method of

marking. Units must stock standard marking kits or use standard field expedient marking procedures. Color coded pickets, fluorescent tape, designated colored chem lights, etc. must be standardized, developed and trained to be effective.

6. UXO Breach / Clearance: All units whether combat, CS or CSS must be prepared to extract themselves from UXO without assistance. UXO will be encountered by units that do not have organic combat engineers or EOD personnel. Proponents must develop doctrine and battle drills based upon the material and personnel available in their units. Armored and mechanized units can "button up" and drive through much of the CBU and DPICM submunitions. However, wheeled and thin skinned vehicles are susceptible to damage and injury to occupants. Dismounted units and aviation units are extremely vulnerable when in areas of UXO. Each unit must address doctrinally how they will conduct their operations in a UXO environment.

TRAINING

1. Identification: Post war interviews with U.S. soldiers indicated that adequate training in the identification of unexploded ordnance was not conducted prior to the ground assault in Desert Storm. Training aids such as inert devices, booklets, and posters, were not available until after the cease fire.[65] Soldiers became casualties when they picked up UXO thinking they were expended flares or duds. Vehicle operators drove into UXO

areas even though they had observed scattered materials and objects. Soldiers are not taught UXO recognition during initial entry training or advanced individual training. Soldiers are taught survival skills to protect them against a potential nuclear, biological and chemical attack. However, the identification and reaction to unexploded submunitions that will be encountered are not taught. Rather than explain the different type munitions that might be used in combat, most soldiers were just told not to touch or pick up any unknown suspicious ordnance or object.

2. Current UXO Training: The Explosive Ordnance Disposal Center for Training and Technology at Redstone Arsenal has been tasked with developing UXO training for the Army.[66] Training is currently being developed in 3 categories:

a. Initial Entry / Officer Basic: The training is designed to provide information on what ordnance items look like and the need to report these items to their superiors. A new 12 minute film titled "Danger UXO" is being distributed to installations for unit safety training and will be shown in basic training. Unfortunately, only 30 minutes has been allocated to teach this to new recruits during their basic training.[67]

b. The second phase involves UXO training at the unit Common Task Training (CTT) / Military Qualification Skills (MQS) II level. Three common tasks are being added to the Soldiers Manual for skill levels 2 through 4. They are Recognize Military Ordnance by Type, Take Immediate Action Based on the Confirmation of a UXO Hazard and Report a UXO Hazard. An additional video titled "The UXO Hazard"

is being produced to support these common tasks.[68]

c. Finally, a block of instruction is currently being staffed for incorporation into the Command and General Staff College. This instruction will address the UXO problem, its effect on the battlefield, and the EOD and engineer resources available for eliminating the hazards.[69]

3. Additional Training: In addition to the individual training just described, collective and unit training must incorporate UXO training. Additional unit ARTEP tasks must be included in manuals and used in unit training and testing to include maneuver exercises at the National Training Center. All units must develop training plans that include general identification of friendly and threat ordnance by their soldiers.

About 99 percent of all UXO can be "blown in place" by units or individuals using rifles and small charges of demolition. EOD personnel still retain the primary responsibility for "turning off" and rendering safe the remaining one percent.[70] Since it is obvious that combat engineers and EOD personnel will not be available in most instances to do this, then selected personnel in every unit must be qualified to destroy UXO.

This training should be conducted similarly to our NBC training for select individuals. Local EOD detachments would conduct training developed by the EOD center, similar to the explosive ordnance reconnaissance agents training that has been available since World War II.[71] Selected company personnel (2 or 3) would be given a 40 hour block of training on how to destroy UXO

with rifle fire or the basic demolition training to blow ordnance by placing a small charge next to the UXOs. Additional skill identifiers would be given to these soldiers with periodic refresher training. These soldiers, like combat engineers, would not be paid hazardous duty pay.

Additional UXO training must be reconsidered for Skill Level 3 soldiers during the basic non-commissioned officer's course (BNCOC). TRADOC disapproved an EOD school proposal to add an advanced UXO recognition and destruction of UXO by using explosives. The original training proposed for BNCOC soldiers in the Infantry, Engineer, Artillery, Armor, Ordnance and Military Police would have added two or three days to the BNCOC schedule.[72] The additional training must also include BNCOC soldiers in Aviation, Transportation, Air Defense, Signal and other specialties that routinely operate independently throughout the battlefield. Branch proponents and senior army leaders must convince TRADOC that NCO's as small unit leaders need this training.

LEADER DEVELOPMENT

The effects of UXO on combat operations and logistics are not well understood by Army leadership. Fortunately, our first large scale involvement with the proliferation of UXO occurred against an enemy who was not strong. U.S. and allied leadership did not have to deal with threat scatterable mines and enemy CBUs or DPICMs.[73]

During Desert Storm, the combined dud rate of multiple engagement with CBUs and DPICMs caused obstacles and safety

concerns for maneuver units. Some maneuver commanders hesitated to employ these munitions, especially if the unit might have to move through the area later.[74] Leaders from squad level through corps must consciously identify specific fratricide risks for any mission.

In order to plan and execute missions in future conflicts, it is important that officers and non-commissioned officers be well trained in all facets of battlefield UXO. The UXO lethality against dismounted soldiers and soft skinned vehicles must be acknowledged by leaders. Many of our key leaders no longer operate from armored or mechanized vehicles, even in heavy divisions. During potential encounters with UXO, wheeled vehicles should remain clear of these areas until lanes have been breached, cleared and properly marked.

The UXO problem will never go away for leaders and will probably increase. Leadership must address UXO lessons learned from Desert Storm and plan for future encounters with the growing problem. Careful guidance and supervision by leaders can reduce our future UXO casualty rate. Senior Army leadership must demand that current and future doctrine and training deal with the UXO on future battlefields.

ORGANIZATIONS

Whenever a unit comes in contact with UXO, it looks for the closest EOD detachment. Since EOD units are not normally co-

located with maneuver units, the unit then tasks its supporting engineer unit to solve its mobility problem. Combat engineers breach and clear the UXO but they are not trained in complex EOD operations and are limited to basic demolition skills and equipment. If an area cannot be by-passed, the engineers will normally breach lanes through UXO areas, mark, report and record the area if time permits. If clearing the area is required, then it becomes a long drawn out mission that takes engineer resources away from their maneuver units.

In today's Army we are facing a decreasing number of EOD and engineer assets while faced with an increasing problem of UXO. Currently it is the mission of EOD detachments and their response teams to "perform reconnaissance, identification, render safe, recovery, field evaluation, and final disposal of unexploded ordnance (UXO).

EOD units are organized for combat by allocation to areas on the battlefield. Each corps is allocated one control detachment and 10 EOD detachments (authorized 23 personnel). Separate divisions are allocated one control detachment and 4 EOD detachments. There is no set doctrine as to how and where they will be located. It is often different in each corps. Support is eventually done on a support area basis, using the five 4 man response teams that make up an EOD detachment. These teams often are dispatched for up to 72 hours with limited supplies, demolitions and communications.[75]

Command and control of EOD detachments is often centralized at

EOD control teams at COSCOM and at TAACOM level. EOD detachments are often co-located with DISCOMs or rear area operations centers (RAOCs). UXO incidents are passed to the detachments or control teams and are prioritized in 4 categories A-D. The response teams work the prioritized incident lists passed from their EOD detachments.[76]

EOD units must be attached to larger tactical units for billeting, mess, security and all classes of supply and maintenance. There is currently no habitual support relationship to maneuver units. Support is on an area basis while EOD elements are attached to various units.

During combat EOD units must be co-located and attached to combat engineer units. Control detachments should be co-located at corps and division TOCs with engineer plans and operations. Since EOD detachments and response teams currently have limited communications and command and control, they should share communications and automated data with engineers. All classes of supply and maintenance support should also be provided by engineer units. Incident control and tracking would continue to be done by EOD detachments and control teams, and should be co-located with engineer assets.

Engineers have limited assets, time and expertise to augment the EOD mission. However, since engineers will be involved with breaching and often clearing efforts involving UXO, then they should habitually work with the EOD subject matter experts. This relationship established during training would carry over to actual

wartime missions. Currently EOD personnel never work with engineers during peacetime training exercises. Division maneuvers both at home station and at the National Training Center should incorporate encountering UXO during the maneuver phases of training. EOD units must be required to train with their habitual engineer counterparts during these exercises.

In addition to the EOD assets being organized for combat with corps and divisional engineer units, an expansion of EOD expertise must be implemented by TRADOC. Army explosive ordnance reconnaissance agents (EORA) at the company level similar to NBC teams must be required. Team members like company NBC personnel would have duties in their primary MOS and hold an additional skill identifier as an EORA. They would not be paid hazardous duty pay. "Each company sized unit is required by Army regulations and MACOM supplements to have two EORAs trained by EOD personnel."[77] EOD units in the field and mobile training teams would provide training to these personnel. The EORAs would interface with the EOD system, provide limited EOD training for their units and advise the commander on dealing with UXO contamination.

MATERIEL

Several materiel fixes must be implemented to eliminate or minimize the effects of UXO. Because of costs and time required for fielding, materiel fixes are the last in the DTLOM process to be implemented. The following materiel fixes must be made:

1. Replace Fuse Systems on Bomblets - Self destruction or self sterilization fuses must be used instead of existing fuses to eliminate duds or reduce duds to less than one percent. Since these bomblets are designed to explode on impact, those that fail to detonate will be treated as UXO. Preference would be to have a fuse or UXO self-destruct to visually see that the UXO has been neutralized not self-sterilized internally. Foreign manufactures (Israel and Germany) currently have DPICM fuses that have these fuses. However, they are too large for our current inventory of submunitions.

Cost estimates from Army Materiel Command (AMC) to replace our existing M223 fuses is estimated to be $2.31 per submunition vice the current 27 cents each. This does not include labor costs to replace the fuses.[78] Also, there would still be some duds. For the Army alone AMC says there are about 850 million bomblets in the inventory of 155mm / 8-inch DPICM.[79] Total cost just for the fuse mechanisms would be about $2 billion. This is the cost to replace fuses and does not include cost to process them. AMC estimates the Air Force and Navy inventory of MK 20 Rockeye, and (GATOR) cluster warhead munitions is "guesstimated" to be another 160 million bomblets.[80] Many of these fuses are epoxyed and riveted in place. Removal and replacement would be labor intensive and hazardous. To download the bomblets from their dispensers, destroy them, and replace with new bomblets would cost 4 - 6 billion dollars.

Both solutions would be eliminated for the less expensive doctrine and training solution fixes. However, the replacement of

munitions expended during Desert Storm must use self destruct fuses. The 15 year shelf life of MLRS bomblets will begin to expire in 1998 and replacement ammunition must have self destruct fuses.

2. Color enhancement of submunitions - Future manufacture of CBU and DPICM bomblets should require bright contrasting colors. International orange bomblets that did not explode upon impact would be easily seen by advancing friendly forces during daylight hours. Since CBU and DPICM is designed to explode upon impact only the duds would remain to be observed by maneuvering forces.

3. Marking Kits - Standardized marking kits must be procured to identify scatterable mines and UXO munitions. Simple markers similar to our NBC marking kits should be fielded to maneuver units. Triangular color coded flags marked as scatterable mines would be installed by any unit that encountered a UXO area.

4. Pop and Drop Munitions - A simple detonator with prepackaged explosive should be developed to "blow in place" UXO that cannot be detonated using the rifle fire technique. Existing methods use one quarter or one half pound blocks of TNT or C4 with a time fuse and a non-electric initiator. These field expedient demolition devices must be fabricated in the field before units can use them to blow UXO. With a self contained detonator and charge, little if any expertise would be required to destroy UXO by "blowing it in place."

5. Mine Plows - A powerful combat mobility vehicle called the "Breacher" is being developed for divisional combat engineer units.

Its large plow will clear lanes through areas of UXO to allow maneuver units to continue. A lighter plow for artillery and mechanized units must be developed for rapid self extraction of maneuver units. These plows would use the vehicle's hydraulic system to operate a "V" shaped plow to skim the surface of the ground to create safe lanes for the remainder of the unit's vehicles to exit the UXO contaminated area. A limited number of tracked vehicles (one per platoon or section) would require the modification to add the blade.

6. Hardening Kits - Kits to protect occupants of soft skin vehicles such as the HMMUV must be developed. Ballistic hardened components such as kevlar floor plates and kevlar doors would protect occupants from exploding UXO. This product improvement would be a bolt-on feature.

7. Army Tactical Command and Control System (ATCCS) - the ATCCS under development should be used to process UXO and scatterable minefield data. Firing artillery, close air support and air interdiction scatterable munitions should be entered into the system. Software must be developed to compute dud rate in areas of submunition impact to predict "footprint" and degree of risk of UXO. Maneuver elements should have access to this equipment and information.

8. UXO Training Munitions - Development of training non-explosive bomblets for bombing or artillery firing must be developed. Use of these inert bomblets would replicate UXO at both local training areas and the National Training Center. The

brightly colored submunitions would be dispensed just like the actual artillery or air delivered munition. The submunitions in the dispensers would be limited to the projected number of duds that would be expected in each dispenser. This would give maneuver units an idea of the magnitude of the UXO problem without endangering them to live ordnance. Training UXO would avoid contamination of training ranges with hazardous live munitions. Maneuver units could then experience the effects of operating in UXO areas without having to "simulate " the effects.

CONCLUSIONS

The proliferation of scatterable submunitions will continue throughout the world. The resulting unexploded ordnance will also continue to be a problem on future battlefields. Many leaders will argue that the relatively low fratricide casualty rate, 104 injuries and 30 deaths, due to involvement with UXO during Desert Storm should be acceptable. These casualty rates seem low when compared to the effort to inflict conservatively 20,000 casualties upon the Iraqi enemy.

Beyond the immediate effects of loss of life and injury the soldier and his unit will be affected with a loss of confidence in his or her training, leadership and equipment. Morale and confidence in supporting air and artillery support will diminish with every UXO incident.

We must accept that when future battles take place, that UXO will remain as a killer on the battlefield. Through proposed changes as discussed in the recommendations in this paper, we can limit the effects of UXO on our soldiers. As leaders we must all strive to eliminate fratricide on future battlefields.

U.S. SUBMUNITIONS USED IN DESERT STORM

Office of Munitions, Secretary of Defense[81]

AIR DELIVERED SUBMUNITIONS

Dispenser	Number	Submunitions per Dispenser	Total	Acceptable 5% UXOs
AF Rockeye/CBU 59	5,345	247/717	Ave 2,576,290	128,815
Navy Rockeye/CBU 59	6,804	247/717	Ave 3,279,528	163,976
AF CBU 87	10,035	202	2,027,070	101,353
AF CBU 52/58/71	17,800	217/650/650	Ave 9,000,867	450,043
AF CBU 89 GATOR	1,105	72	79,560	3,978
Navy CBU 78 GATOR	148	60	8,880	444
Marine CBU 78 GATOR	67	60	4,020	201
TOTAL			16,976,215	848,810

ARTILLERY DELIVERED SUBMUNITIONS

Army 155 DPICM	17,405	88	1,531,640	76,582
Marine 155 DPICM	7,963	88	700,744	35,037
Army 8" DPICM	2,044	180	367,920	18,396
Marine 8" DPICM	58	180	10,440	522
MLRS	17,286	644	11,132,184	556,609
ADAM/RAAM	0			
VOLCANO	0			
AATACM	32	950	30,040	1,520
TOTAL			13,773,328	688,666

FIGURE I

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