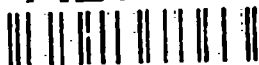


AD-A251 828



2

STUDY PROJECT

The views expressed in this paper are those of the author and do not necessarily reflect the views of the Department of Defense or any of its agencies. This document may not be released for open publication until it has been cleared by the appropriate military service or government agency.

FRATRICIDE: A PREVENTABLE TECHNOLOGICAL DISEASE

BY

Lieutenant Colonel Michael P. O'Connor
United States Air Force

DTIC
ELECTE
JUN 16 1992
S A D

DISTRIBUTION STATEMENT A: Approved for public release.
Distribution is unlimited.

USAWC CLASS OF 1992



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

92-15685



92 0 20 043

REPORT DOCUMENTATION PAGE				Form Approved OMB No. 0704-0188	
1a. REPORT SECURITY CLASSIFICATION Unclassified			1b. RESTRICTIVE MARKINGS		
2a. SECURITY CLASSIFICATION AUTHORITY			3. DISTRIBUTION / AVAILABILITY OF REPORT		
2b. DECLASSIFICATION / DOWNGRADING SCHEDULE					
4. PERFORMING ORGANIZATION REPORT NUMBER(S)			5. MONITORING ORGANIZATION REPORT NUMBER(S)		
6a. NAME OF PERFORMING ORGANIZATION U.S. Army War College		6b. OFFICE SYMBOL (If applicable)	7a. NAME OF MONITORING ORGANIZATION		
6c. ADDRESS (City, State, and ZIP Code) Carlisle Barracks, PA 17013-5050			7b. ADDRESS (City, State, and ZIP Code)		
8a. NAME OF FUNDING / SPONSORING ORGANIZATION		8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER		
8c. ADDRESS (City, State, and ZIP Code)			10. SOURCE OF FUNDING NUMBERS		
			PROGRAM ELEMENT NO.	PROJECT NO.	TASK NO.
11. TITLE (Include Security Classification) Fratricide: A Preventable Technological Disease					
12. PERSONAL AUTHOR(S) Lieutenant Colonel Michael P. O'Connor					
13a. TYPE OF REPORT Individual		13b. TIME COVERED FROM _____ TO _____		14. DATE OF REPORT (Year, Month, Day) 23 March 1992	
15. PAGE COUNT 38					
13. SUPPLEMENTARY NOTATION					
17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)		
FIELD	GROUP	SUB-GROUP			
19. ABSTRACT (Continue on reverse if necessary and identify by block number) Commanders who lead their troops in combat realize that they may suffer casualties in the process. This is an inevitable by-product of war and is taken for granted. However, they do not take for granted that a portion of their casualties will be inflicted by their own forces. Yet, in each of America's wars from World War I through Operation Desert Storm, a significant number of U.S. personnel have been killed and wounded as a direct result of friendly fire/fratricide. A brief review of some of these documented fratricide incidents and associated causes is provided. With the observation that technological advances to prevent fratricide has not kept pace with today's sophisticated modern weapon systems, current anti-fratricide methods and future materiel solutions are detailed in this paper.					
20. DISTRIBUTION / AVAILABILITY OF ABSTRACT ☐ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT ☐ DTIC USERS			21. ABSTRACT SECURITY CLASSIFICATION		
22a. NAME OF RESPONSIBLE INDIVIDUAL NEAL J. DELISANTI			22b. TELEPHONE (Include Area Code) 717-245-4016		22c. OFFICE SYMBOL AWCAC

USAWC MILITARY STUDIES PROGRAM PAPER

The views expressed in this paper are those of the author and do not necessarily reflect the views of the Department of Defense or any of its agencies. This document may not be released for open publication until it has been cleared by the appropriate military service or government agency.

FRATRICIDE: A PREVENTABLE TECHNOLOGICAL DISEASE AN INDIVIDUAL STUDY PROJECT

by

Lieutenant Colonel Michael P. O'Connor
United States Air Force

Colonel Neal J. Dellisanti
Project Adviser

U.S. Army War College
Carlisle Barracks, Pennsylvania 17013



DISTRIBUTION STATEMENT A: Approved for public release; distribution is unlimited.

Accession For	
NTIS	CRA&I ☒
DTIC	TAB ☐
Unannounced ☐	
Justification	
By	
Distribution/	
Availability Codes	
Dist	Avail and/or Special
A-1	

ABSTRACT

AUTHOR: Michael P. O'Connor, Lt. Col, USAF

TITLE: Fratricide: A Preventable Technological Disease

FORMAT: Individual Study Project

DATE: 23 March 1992 **PAGES:** 38 **CLASSIFICATION:** Unclassified

Commanders who lead their troops in combat realize that they may suffer casualties in the process. This is an inevitable by-product of war and is taken for granted. However, they do not take for granted that a portion of their casualties will be inflicted by their own forces. Yet, in each of America's wars from World War I through Operation Desert Storm, a significant number of U.S. personnel have been killed and wounded as a direct result of friendly fire/fratricide. A brief review of some of these documented fratricide incidents and associated causes is provided. With the observation that technological advances to prevent fratricide has not kept pace with today's sophisticated modern weapon systems, current anti-fratricide methods and future materiel solutions are detailed in this paper.

INTRODUCTION

As American units wheeled and maneuvered to execute the huge flanking movement that was to encircle and destroy Iraqi ground forces, the fringes of two U.S. Army Corps became entangled. An armored cavalry unit, spotting the combat engineers on its perimeter, grew convinced that they were Iraqis; the engineers thought the same of the cavalry. What followed was chilling and tragic.

The troopers issued a radio challenge, followed by a warning in Arabic. They fired shots over the engineers' heads. Then the cavalry advanced. The engineers ran. From a pursuing Bradley Fighting Vehicle came a machine gun burst...One soldier dead, a fellow engineer badly-wounded- victims of the oxymoron known as "friendly fire."¹

This is just one example of the many alarming incidents of Americans killed and wounded by American fire in Operation Desert Storm. These incidents of fratricide may be the most demoralizing tragedy a combat unit can experience. The overall reduction in combat effectiveness appears to be even greater than if the enemy had inflicted the damage. Besides the friendly personnel who are injured or killed, the individuals who pulled the triggers can be so psychologically upset that they are subsequently ineffective for further combat duty.

Historically speaking, fratricide has not been a serious problem until now. Allied fire accounted for roughly 2 percent of American casualties in previous wars during this century.² In the Gulf War, however, 35 of 148 Americans killed in combat died as a result of friendly fire, nearly 25 percent. In addition, of the 467 Americans wounded, 72 of them were injured by their own forces.³

This horror of war has worsened with the advent of more sophisticated "high-tech" weapons of greater range, precision, and

lethality. Tank crews, attack helicopter pilots, and fighter pilots can all fire weapons with tremendous destructive capability and also, well beyond target identification range. From an airpower perspective alone, Lieutenant General Charles A. Horner, the commander of allied air forces in Operation Desert Storm, told the Senate Armed Services Committee in May 1991 that, "With the lethality of air (power) now, a hit on a friendly vehicle is a disaster." 4

Yet, while modern weapons have furthered the military's combat firepower, technology that can help U.S. fighting personnel maintain situational awareness and differentiate between friends and foes in difficult combat conditions has lagged. The underlying thesis of this paper is that the U.S. military must pursue advanced technology solutions for combat weapon systems in order to prevent fratricide in future wars. The scope of this thesis has been narrowed to specifically address the Army and Air Force, although much of it could likewise pertain to the Marines and Navy.

The paper will address this issue by first analyzing historical examples of fratricide from modern warfare. Then a discussion of the current anti-fratricide methods and any associated problems will be presented. Next, will follow an outline of materiel solutions that the Army and Air Force are pursuing to prevent future incidents of fratricide. Finally, the paper will culminate with conclusions and some recommendations for preventing future friendly fire casualties.

HISTORICAL EXAMPLES OF FRATRICIDE

In order to get a perspective on the seriousness of fratricide, a brief look at some documented cases from previous wars is necessary. This review is displayed in four descriptive categories: air-to-ground, ground-to-ground, ground-to-air, and air-to-air fratricide. Air-to-ground fratricide, pertains to incidents in which friendly aircraft, either fixed wing or helicopter, bomb, strafe, or rocket friendly ground forces. The second category, ground-to-ground fratricide, involves friendly ground troops firing upon other friendly ground forces. This category includes incidents involving friendly armored vehicles, artillery, mortars, and rocket systems. The third category deals with ground-to-air fratricide in which friendly ground forces fire upon friendly aircraft. The final category is air-to-air fratricide, which involves friendly aircraft shooting at other friendly aircraft.

Many examples have been taken from Lieutenant Colonel (LTC) Charles R. Shrader's research survey, Amicicide: The Problem of Friendly Fire in Modern War. His survey extracted examples of friendly fire incidents from literature on World War I, World War II, the Korean War, and the Vietnam War. The remaining examples involve verified cases of fratricide during Operation Desert Storm.

Air-to-Ground Fratricide

World War II. An important chapter in the allied breakout from Normandy in 1944 was the penetration and later breakthrough in the area of St. Lo. This plan was code named Operation Cobra and included the most extensive close air support effort ever attempted.⁵ When viewed in its entirety, Operation Cobra was a well-planned and highly successful attack by combined air and ground forces. However, it also resulted in "the most devastating incident" of fratricide ever to occur.⁶

The Cobra concept of operation called for three phases. Planners concentrated the majority of the air support in phase one. This phase included an intensive aerial bombardment by heavy, medium, and fighter bombers coordinated with heavy concentrations of artillery fire.⁷ Three Allied Infantry divisions would exploit this bombardment by breaking into German positions.

Planning for the air strikes of phase one was based on previous Allied experience with the Air Force, where a lack of coordination and target misidentification had frequently resulted in bombing friendly ground forces. This was to be avoided this time by better preparation and coordination.⁸ To mark the forward edge of the target area for this air attack, a terrain feature easily recognizable from the air was needed and the straight St. Lo-Perrier highway was selected. To further reduce the risk of short bombing, General Bradley desired that the bomb runs be made

from East to West, parallel to the St. Lo-Perlier road and that only targets south of the road be given to the Air Force.⁹

The German forward positions were marked with red smoke by Allied artillery and Allied tanks, and armored vehicles were marked with fluorescent panels to facilitate recognition from the air. Also, the Allied white star insignias were repainted on all of the participating vehicles.¹⁰

After several postponements due to poor weather, the air operations of Operation Cobra started on 25 July and marked the most effective sustained close air support in history. Approximately 1500 heavy bombers, 400 medium bombers, and 700 fighter bombers conducted saturation bombing of an area 2500 yards deep by 7000 yards wide immediately to the south of the St. Lo-Perlier highway.¹¹ For this bombardment several alterations had been made in a final attempt to avoid a repetition of the bombing error which had happened only the previous day causing 25 dead and 131 wounded from the 30th Infantry Division.¹²

However, disastrous mistakes still occurred which resulted in 111 killed and 490 wounded on this second day of erroneous bombing.¹³ Mechanical malfunctions, such as gun sight or bomb rack problems, as well as failures to properly identify targets, compounded by poor visibility due to smoke and dust over the target area and the St. Lo-Perlier road, were major causes of the fratricide.

Vietnam War. Mechanical malfunctions, such as those previously mentioned, misidentification of targets, and problems concerning friendly troop location and marking continued to play a role in fratricide incidents in the Vietnam War.¹⁴ Helicopters and jet fighters played an important role in close air support operations and both types of aircraft were involved in numerous fratricide incidents.

One such incident involved helicopter gunships of the 187th Assault Helicopter Company. They came in contact with an unidentified company-size force, and since no friendlies were reported in their area, the helicopter fired. Unfortunately, the ground force turned out to be a unit of the 25th ARVN Infantry Division and several soldiers were wounded before the unit could identify itself.¹⁵

On another occasion two F-100s were flying an immediate close air support mission in order to assist two companies of U.S. soldiers in close contact with the enemy. After successfully dropping their bombs, the aircraft made strafing runs at the request of the ground commander. With darkness approaching, one pilot became disoriented and strafed the friendly position resulting in two soldiers killed and seven wounded.

Operation Desert Storm. The Pentagon confirmed that U.S. Air Force and Marine Corps fighters and one Army gunship committed ten friendly fire incidents during the Gulf War.¹⁶ The casualty toll

was twenty-six Americans and twenty British soldiers killed or injured.¹⁷

The Army suffered casualties in only two of these incidents. The most serious incident occurred at night on 17 February 1991. Amid a blinding sandstorm, the commander of an attack helicopter battalion mistakenly identified U.S. armored vehicles as the enemy. From his AH-64 Apache helicopter, he fired two Hellfire missiles which slammed into a Bradley Fighting Vehicle and an M-113 armored personnel carrier. Two U.S. soldiers were killed and six were wounded.¹⁸

By contrast, Marines were victims in five cases of air-to-ground fratricide. One of these incidents happened on 29 January 1991, when an A-10 fired a Maverick missile that hit a Light Armored Vehicle during a night mission.¹⁹ Air Force officials said the Maverick apparently lost its lock on the intended Iraqi target, malfunctioned, and destroyed the Marine vehicle, killing seven Marines and injuring two others.²⁰

Another incident occurred when an air-launched High-Speed Anti-Radiation Missile (HARM) hit a Marine radar unit killing one Marine.²¹ The peculiarity of this incident and three others involving HARMs was that when a targeted enemy radar was turned off after the HARM was launched, the HARM began searching for a new target that met the same parameters. Unfortunately, according to investigations, at least four HARMs transferred lock to secondary targets, which just happened to be U.S. radars.²²

The worst air-to-ground incident during the Persian Gulf War occurred 27 February 1991. Two A-10s fired Mavericks which hit two British Warrior armored personnel carriers killing nine British soldiers and wounding eleven others.²³

I personally interviewed the two A-10 pilots after they landed from their mission. Based upon target location data supplied to them by their British ground forward air controller, as well as, F-16s that had just worked the same target area, the A-10 pilots thought they were over the correct target. Neither of them could positively identify the vehicle, even with their binoculars, and they could not see any orange panels on the vehicle that would identify them as friendly. Consequently, they each fired a Maverick at what they thought was an Iraqi armored column. Unfortunately, it was not.

Ground-to-Ground Fratricide

World War I. The shelling of friendly troops by their own artillery was a common occurrence on the western front. The result, according to a certain French general, was "nothing less than the outright massacre of friendly infantry by its own artillery."²⁴ By his calculations the French suffered 75,000 casualties due to friendly artillery in World War I.²⁵

World War II. In November 1944 American units attacked the German lines in the Saar-Moselle triangle. In particular, on 23 November, units of the 358th Infantry Regiment and Combat Command A (CCA) of

the 10th Armored Division attempted to secure a bridgehead over the Saar River at Saarburg.²⁶ Due to obvious poor planning and coordination, the infantry units came under fire from friendly tanks and artillery. Many of the soldiers were killed or wounded and the attack bogged down.²⁷

Korean War. In April 1951 elements of the British 29th Brigade attempted to withdraw from their defensive position along the Imjin River north of Seoul.²⁸ During its retreat, Company D of the Gloucester Regiment encountered American tanks that were firing at Company D's Chinese pursuers. Unfortunately, the Americans also mistook the British soldiers as part of the Chinese onslaught and killed six of the Glosters with heavy fire before the British could identify themselves.²⁹

Vietnam War. Although the U.S. employed a limited number of tanks in Southeast Asia, one incident of fratricide between friendly armor and infantry did occur. In September 1969 a Sheridan tank of the 1st Cavalry Division mistakenly identified a friendly position and fired upon U.S. soldiers manning a perimeter position at Quan Loi base camp, killing seven Americans.³⁰

The rugged terrain of Vietnam coupled with breakdowns in command and control often contributed to fratricide incidents. One such incident occurred in Pleiku Province in June 1966 involving two platoons of Company C, 1-35th Infantry. Although the company commander gave each of his platoons specific routes for a search and destroy mission, one platoon became disoriented and got into

the path of another platoon. A skirmish ensued and before the firing stopped four soldiers were wounded.³¹

Operation Desert Storm. Operation Desert Storm was the largest armored battle in history. It consisted of 100 hours of intense combat with over 400 miles of movement in continuous, fast-paced and highly lethal operations. Much of the fighting in the ground war took place at night and in heavy rainstorms or swirling sandstorms which made the identification of friend from foe a difficult task.

As a result of its investigation of combat losses during the war, the U.S. Training and Doctrine Command (TRADOC) identified fifteen ground-to-ground friendly fire engagements involving U.S. or British forces. These incidents killed 19 soldiers and wounded 59 others.³² The primary cause of the casualties was the misidentification of forces during offensive operations in reduced visibility conditions. These engagements also destroyed seven '1A1 tanks and twenty Bradley Fighting Vehicles, roughly 77 percent of the U.S. Army's materiel losses.³³

The most disastrous U.S. fratricide incident of the war occurred in the early-morning darkness of 27 February 1991. In what became known as the Battle of Norfolk, elements of the U.S. 1st Infantry Division tangled with the Tawakalna Division of the Republican Guard and other Iraqi units. On several occasions, when the Iraqis fired rocket-propelled grenades (RPGs) at the U.S. vehicles, American gunners using thermal sites mistook the RPG

flashes bouncing off the U.S. tanks for enemy tank fire and unleashed destructive barrages on their own troops.³⁴ During this chaotic night fight, six Americans died and twenty-five more were wounded. Also, five Bradleys and five M1A1 tanks were lost.³⁵

Ground-to-Air Fratricide

World War II. During the North African campaign, fighter-bombers of the XII Air Support Command tried to assist the American retreat at Kasserine Pass. Their assistance was thwarted by American antiaircraft artillery (AAA) that shot up five planes beyond repair and turned back two of the air missions.³⁶ The next day friendly AAA damaged five American P-38s despite their distinctive shape and despite the fact that the aircraft rocked their wings as they flew over friendly forces. To prevent a similar occurrence the commander of XII Air Support Command ordered ground troops not to fire at an aircraft unless it had attacked them first, a precursor of today's weapons control orders.³⁷

In the Pacific Theater incidents of fratricide involving friendly AAA also took place. At night on D-Day, during the invasion of Cape Gloucester (New Britain), friendly AAA engaged a friendly B-24 that did not squawk the appropriate identification friend/foe as it approached the beachhead. Fortunately, the pilot evaded the AAA fire and no one was hurt.³⁸

Vietnam War. LTC Shrader reported only one friendly fire incident during this war. Troops at a fire support base near Chu Lai mistakenly fired at an American UH-1H helicopter. No one was hurt.

Operation Desert Storm. There were no fratricide incidents involving Coalition air defense systems and friendly aircraft. This was due to the fact that all surface-to-air weapons systems were kept under strict weapons control orders and also that antiaircraft responsibility was limited to the fighters. For example, on 24 January 1991 a Saudi F-15 shot down two Iraqi Mirage F-1s. However, a Hawk missile battery had tracked the same Mirage for some time, but was prohibited from firing.³⁹

Fortunately, Coalition fighters owned total air superiority in the theater of operations. So, the assumption was that any aircraft seen overhead by Coalition ground forces would be considered friendly. Was this a false assumption? It is unknown, but, with the almost non-existent Iraqi air threat, it never had to be put to a real test.

Air-to-Air Fratricide

Research did not yield any incidents in this category. However, it is worthy to note that in the Gulf War U.S. Central Command Air Forces (CENTAF) instituted rigid rules of engagement (ROE) to preclude any friendly aircraft engagements. This was especially important because the Iraqis flew a type of jet that was also used by the Coalition (e.g., Mirage F-1).

Generally speaking, CENTAF's ROE required fighters to identify an airborne target through two independent methods of electronic identification. Only then would the E-3 Airborne Warning and Control System (AWACS) aircraft declare the target as hostile and provide clearance to engage.⁴⁰

Although cumbersome, the ROE worked well. However, one must remember that it worked well in an environment that had very limited enemy air activity. This may not be the case in the future.

CURRENT ANTI-FRATRICIDE METHODS

The Army and Air Force have employed various methods to enhance fratricide prevention. Three of these means are airspace management, equipment, and joint training. A discussion of each of these and some of their associated problems follows:

Airspace Management

Maximum combat effectiveness, as well as fratricide reduction, can only be achieved, if land and air operations are optimally coordinated; land and air forces support and augment each other; and mutual interference is avoided.

Today's Airspace Control Plans (ACPs), for the various theaters of operations, are a compromise between the conflicting interests of the airspace users. These plans define the means for Airspace Control Areas and sub-areas (i.e., minimum risk routes, low level transit routes, restricted operating areas, base defense

zones). In order to adapt these airspace control means to changing situations, active measures are altered by Airspace Control Orders (ACOs). This is a very time-consuming process that involves all levels of command of all forces in the area of responsibility.

This is certainly not the flexibility required in combat, with ever changing situations and demands. In particular, short-range air defense weapon systems probably could not be used to their best advantage, due to restrictive fire control orders. Moreover, offensive air assets are restricted to fixed routes to avoid being shot down by friendlies.

In the Gulf War there was an attempt to develop airspace control procedures. CENTAF published routes and altitude blocks in the Air Tasking Order (ATO) that offensive fixed-wing aircraft were to follow when flying to and from the target areas. However, from the start the routes were a burden because they usually took you too far out of your way costing precious time and fuel. It did not take long before pilots totally disregarded these routes, as long as they were in positive radar contact with a control and reporting center and/or an AWACS aircraft. No significant changes were made to the airspace control procedures during the war. However, since a real air threat never materialized and since the Coalition had total air superiority, one could imagine why there would be no real concern with airspace control.

Research failed to point out any attempt to coordinate use of the airspace over the battlefield with the ground forces once the ground war began. It appears the "shoot'em down and sort'em out or

the ground" and the "big sky, little bullet" theories persisted. Fortunately, for everyone concerned, the ground war lasted only four days and the Coalition had total air superiority over the battlefield. Otherwise, the potential fratricide of friendly air assets could have been considerably higher.

Equipment

Currently, the U.S. Army has both sophisticated and unsophisticated devices that help reduce the risk of friendly fire. All but one of these means were used during Operation Desert Storm.

Specifically, fluorescent orange VS-17 panels were added to combat vehicles to help pilots identify friendly forces. Unfortunately, these panels were only effective during daylight hours and were often noneffective due to reduced visibility or equipment covering the panels. Even using binoculars, pilots often had problems seeing these panels.

Another unsophisticated solution was the inverted "V" that was painted on vehicles to aid in ground-to-ground identification. Again, these markings could only be seen during the day. Both the panels and the vehicle markings were reminiscent of World War II anti-fratricide devices.

The Army's night vision laboratories in 1988 invented a small, lightweight, infrared beacon known as the "Budd Light."⁴¹ These lights could be strapped on to vehicles or soldiers to serve as a warning signal to friendly ground forces. However, the Budd Lights are line-of-sight devices and can only be seen through night vision

goggles. During the Gulf War only the 24th Infantry Division had these lights.⁴²

Shortly after a major air-to-ground friendly fire incident occurred during the Gulf War, the Joint Chiefs of Staff (JCS) headed an emergency search for a system to help pilots identify friendly vehicles. General Michael P. C. Carns, who at that time was the Director of the Joint Staff, discussed the JCS project immediately with the Director of the Defense Advanced Research Projects Agency (DARPA).⁴³ In an extraordinary government-industry effort, the U.S. fielded in 19 days 10,000 infrared beacons known as "DARPA Lights."⁴⁴ Some arrived in Saudi Arabia before the cease fire, but none got there in time to be tested in combat. These lights operated essentially the same as the Budd Lights and had basically the same advantages and disadvantages.

One of the major problems faced by U.S. ground forces was navigating in a featureless environment. The Navigation Satellite Timing and Ranging (NAVSTAR) Global Positioning System (GPS) helped to alleviate their problem. GPS provided position location and navigation information to soldiers equipped with the Small Lightweight GPS Receiver (SLGR).

In fact, the Army rushed more than 7,500 of these satellite navigation devices to Army units in Saudi Arabia.⁴⁵ The SLGR's however, were commercial off-the-shelf items that could not take full advantage of the GPS capabilities. Specifically, the GPS was designed for signal encryption to deny satellite information to the enemy. If this mode of the GPS, known as Selective Availability

(SA), was turned on, then ground receivers had to be equipped with a decoding device to receive full GPS data.⁴⁶ Commercial receivers, such as the Army's SLGRs, did not have the SA capability. So, when the Army made the quick purchase of these devices to support the units in the desert, the government decided to turn SA off and risk Iraqi exploitation.⁴⁷

Fortunately, Iraq did not have the weapons systems to exploit the use of GPS, so risk to Coalition ground forces was minimal. However, this may not be the case in future conflicts. "In fact, advertisements have already appeared in print offering GPS-equipped aircraft on the international arms market."⁴⁸

The best known and most effective anti-fratricide capability stems from the U.S. military's electronic identification friend or foe (IFF) systems. The Air Force and Army have used IFF in their aircraft for decades and the Army has IFF interrogation capability on some of its air defense artillery weapons (e.g., Stinger, Hawk, Patriot). No electronic IFF system exists for use on ground combat vehicles.

IFF technology revolves around cooperative and noncooperative means of target identification. Cooperative identification requires the target to actively provide data which can be used for identification purposes, such as responding to electronically received interrogations. Today's MK X and MK XII military IFF systems operate in this manner.

For noncooperative target recognition (NCTR), a target does not purposely provide the necessary data. The target can be

Identified through analysis of information gathered about the target from various means. For example, the F-15C can recognize targets based on jet engine turbine or compressor blade rate.⁴⁹

Since its inception, there have been progressive developments in IFF in order to keep ahead of advancing electronic counter measures (ECM) technologies, target characteristics, and performance. Still the MK X and MK XII systems had their shortcomings that prompted the NATO Conference of National Armaments Directors more than 15 years ago to call for a new identification system.⁵⁰ "Supreme Headquarters Allied Powers Europe has castigated inadequate IFF as 'the single most glaring deficiency in air defense.'⁵¹

NATO member nations decided, at the end of the 1970s, that a common IFF system should be developed within the alliance. This system became known as the NATO Identification System (NIS) and was later formalized under Standardization Agreement 4162.⁵² NIS was to have a direct element, using IFF interrogators and transponders similar to current systems, and an indirect identification subsystem. The indirect subsystem (ISS) was a data fusion process that would combine NCTR data along with inputs from electronic support measures equipment and the direct element.⁵³

The U.S. candidate for the direct element was the MK XV IFF system. Unfortunately, for the U.S. military and for NATO, the U.S. cancelled in February 1991 its MK XV program.⁵⁴ No definite reason was given other than the Air Force preferred NCTR technologies over cooperative IFF systems like the MK XV. In

addition to cancelling the MK XV program, the U.S. drastically cut ISS funding.

Meanwhile, the Department of Defense (DoD) has tasked the services to revalidate their IFF requirements. Until they do this, the DoD will delay its decision on the IFF road map for the future.

Joint Training

Close air support (CAS) is a very critical mission for the Air Force that requires a lot of training and interoperation with the Army. Short of actual war, the Air Force conducts its best CAS training at the National Training Center (NTC) at Fort Irwin, California. This is one of the few places in the world where CAS can be flown in a realistic environment both in force-on-force (simulated fire) and actual live fire. Unlike dedicated Air Force exercises, such as Red Flag, where CAS aircraft (e.g., A-10s, F/A-16s) fly mainly battlefield air interdiction missions instead of CAS, NTC is an Army exercise where realistic coordination problems occur resulting in valuable lessons learned.

Time spent at the NTC strengthened the training for those pilots who eventually deployed to Saudi Arabia, but their learning process did not stop at the NTC. For example, deployed A-10s flew 16,233 sorties between August 1990 and 28 February 1991, and 57 percent were flown before the war started.⁵⁵ Furthermore, the majority of these pre-war sorties involved training with deployed ground units.

If Operation Desert Storm did one thing, it highlighted the concern about fratricide. It also brought out, perhaps, a glaring deficiency of CAS training at the NTC. Air Force CAS aircraft do not carry any instrumentation, such as the Multiple Integrated Laser Engagement System (MILES), that would tell a pilot when he has "killed" a target or "was killed" by enemy fire. Currently, only ground vehicles and helicopters carry the MILES equipment.

As mentioned earlier, the conflicting interests of airspace users cause real problems in the area of airspace control. One of the most pressing concerns is the ability of fighters and surface-to-air missiles to conduct air defense operations in the same airspace without the risk of fratricide. The Army and Air Force have worked together to formulate a joint engagement zone (JEZ) concept to help correct this problem.

JEZ procedures have been tested as part of the USAF's Green Flag training exercises at the Nellis Air Force Base range complex in Nevada.⁵⁶ Participants included Army Patriot and Hawk units as well as Air Force tactical fighters and AWACS aircraft. The training exercises have proven highly successful with valuable lessons learned, and both services are committed to making the JEZ concept work. Again, the almost total lack of Iraqi air activity during the Operation Desert Storm precluded a combat test of the concept.

FUTURE MATERIEL SOLUTIONS

The lack of proper planning and coordination contributes significantly to wartime casualties. However, the lack of positive target identification capability and the inability to maintain situational awareness in combat environments are the major contributors to fratricide. With the tremendous improvements in the accuracy and destructive power in today's weapon systems, the consequences of friendly fire incidents are more serious than ever.

In the aftermath of the Gulf War, the Army and Air Force have stepped up the pace to find technological answers that would help reduce fratricide in future conflicts. Following are some of the specific materiel solutions that the two services are pursuing.

Combat Identification Program

In May 1991, the Army Chief of Staff tasked the Commanding General (CG), U.S. Army Training and Doctrine Command along with the CG, U.S. Army Materiel Command, to establish a comprehensive program to address positive combat identification. In response to their tasking, the CGs established a Combat Identification Task Force, which included representatives from various Army organizations as well as representatives from the USAF Tactical Air Command and the United States Marine Corps (USMC) Combat Developments Center.⁵⁷

After several months of identifying needs, outlining solutions, and developing programatics, the task force proposed

their anti-fratricide solutions, which ranged from doctrinal changes to materiel fixes. Their strategy for developing and fielding combat identification hardware was to put some capability into the hands of soldiers as quickly as possible and then improve incrementally on this capability. To accomplish this strategy, the task force organized the materiel development and fielding into four phases: Quick Fix/Quick Fix Plus, Near, Mid, and Far Term.⁵⁸

The specific Quick Fix solutions included the Budd Light, DARPA Light, and SLGR, previously discussed. Another item, however, in the Quick Fix category was thermal tape. This material could be applied to vehicles and would give off an infrared (IR) signature visible by thermal imaging devices at close range, day or night. With the exception of those devices currently in the inventory, the Army expects to field these items by early 1993.

The task force identified thermal beacons, integrated SLGR, laser warning receivers, and compass/azimuth indicator as Quick Fix Plus solutions. Thermal beacons would provide an IR signature just like thermal tape but at much greater ranges. Integrated SLGR would permanently mount SLGRs in tanks and Bradleys. Laser warning receivers would warn combat vehicle crews that they were being lased by friendly or enemy weapons. The compass/azimuth indicator system would provide hull and gun coordination to gunners at all times. The Army intends to quickly assess these solutions and select the most promising in order to field the hardware by mid 1993.⁵⁹

In June 1991, U.S. Army Laboratory Command solicited industry for near term solutions. Out of the forty-eight contractors that responded, the Army picked five companies for a Near Term combat identification program. The companies and their respective proposals were:

1. Hughes Aircraft Co.'s Ground Systems Group with its Laser Interrogate-Radio Frequency Reply System.

2. Magnavox Government and Industrial Electronics Co. with its Low Probability of Detection, Interrogation and Reply with Embedded GPS.

3. Litton Systems Inc.'s Laser Systems Division with its Laser Retro-Responder system.

4. AIL Systems with its Laser Detection with Multispectral Beacons system.

5. Raytheon Co.'s Equipment Division with its Interrogation and Reply Utilizing GPS.⁶⁰

These solutions incorporate an active laser or radio frequency (RF) signal interrogation coupled with a cooperative RF, laser or infrared reply from the target. The companies are scheduled to demonstrate their prototypes beginning in April 1992 at Fort Bliss, Texas, at which time, the Army will determine which solution offers the best potential for acquisition.⁶¹ The Army hopes to have the selected hardware fielded within three years.⁶²

Mid Term solutions will build on preceding ones and will initiate technology base programs for improved situational awareness, improved friendly identification and improved optics. The timeline for fielding Mid Term devices is three to seven years.⁶³

Far Term proposals will initiate technology base programs to develop an integrated, embedded situational awareness and positive friendly friend/foe identification capability. It will take seven years or longer to field this hardware.⁶⁴

Besides the materiel solutions proposed by the task force, there are a number of weapon, fire control, C3I, and target acquisition systems that are currently undergoing development. These include items such as improved optics for combat vehicles, the Precision Lightweight GPS Receiver (PLGR), the Inter-Vehicular Information System, and the Single Channel Ground and Airborne Radio System. The Army intends to "harmonize Combat ID materiel efforts with these systems and where possible, leverage any Combat ID contributions which they may provide."⁶⁵

A very important aspect of this task force is that it was not strictly a parochial effort by the Army, but rather a joint venture to solve a common problem. This is especially important when dealing with the aspect of air-to-surface fratricide. If the Army is going to field devices to put on friendly vehicles in order to aid friendly aircraft in identifying them, then these devices must be compatible with aircraft systems.

Air Force Initiatives

The Air Force has also undertaken some technical improvements to enhance combat effectiveness while, at the same time, reducing friendly fire losses. F/A-16s are getting an enhanced computer capability to improve bombing and strafing accuracy. To improve

night operations, F/A-16s will also have second-generation forward looking infrared (FLIR) in the aircraft's low altitude navigation and targeting infrared for night (LANTIRN II) system. LANTIRN has finally given the Air Force the capability to support the Army around the clock.

The F/A-16 and OA-10 aircraft are expected to receive the Automatic Target Handoff System (ATHS). The ATHS enables a fighter's targeting computer to communicate directly via data bursts to computers in other aircraft or on the ground.⁶⁶

Normally, a forward air controller (FAC), either in the air or on the ground, would give a pilot a nine-line brief over the radio. The brief would include the fixed initial point (IP); the magnetic heading from the IP to the target; the distance from the IP to the target; the target elevation; target description; target coordinates (in grids or latitude and longitude); whether the target is marked and if so, with what (smoke, laser); the location of any friendlies; and surface-to-air threats. The FAC would also provide any other information that he felt the attack pilot should have. This briefing would take a lot of time due to communications jamming, radio static, chatter from others on the same frequency, etc. The attack pilot would also have to manually input the briefing information into his computer then coordinate with his wingman to insure that he also received the briefing.

The ATHS, on the other hand, reduces voice communication, increases targeting accuracy, and vastly improves tactical coordination. Air liaison officers (ALOs) assigned to ground

combat units will have laptop computers hooked directly into the ATHS network. The ALOs can transmit all of the nine-line data directly into an aircraft's computer almost instantaneously via data burst. Also on the ATHS network will be airborne command and control aircraft, Army scout and attack helicopters, and GPS satellites.⁶⁷

A significant hurdle that ATHS must overcome is the computer compatibility problems between the USAF's Tactical Air Request Net (TARN) and the Army's Tacfire network. The Tacfire network is totally compatible with ATHS. However, the USAF's TARN, which is now "voice only" is expected to get digital communications terminals, but these new terminals are not compatible with the Army's digital Tacfire net.⁶⁸ This is a crucial problem for ground commanders who have to go through a complex routine for getting Air Force CAS.

Regardless of this problem, which the services are attempting to overcome, the ATHS has significantly enhanced target identification. Unfortunately, Coalition forces did not have the ATHS during Operation Desert Storm.

Another technical improvement that will enhance the effectiveness of CAS missions is the GPS. The Air Force has already identified money to outfit OA-10 FAC aircraft with GPS receivers. However, money has not been allocated to put the receivers on the A-10, the Air Force's primary CAS platform.⁶⁹

Although not specifically designed for the Air Force, Martin Marietta is developing a FLIR based automatic target recognition

system. This system is primarily being developed for the Army's new Comanche reconnaissance/attack helicopter, but has the potential for use as an air-to-ground IFF system for fighters.⁷⁰

Costly Decision for the Services

Currently, political momentum is running against additional military spending. In fact, concerned about the U.S. economy, education, health care, and other domestic issues, more and more Americans are concluding that "the time for pouring most of their tax dollars into the enormous military budget is nearing an end."⁷¹

In 1990, Congress and the Bush Administration set in motion a 25 percent reduction in military force structure and spending over the next five years. This was a tremendous about-face from the Reagan military buildup during the 1980s.

Still, calls for even faster and deeper cuts in defense spending than originally planned for by the Pentagon, have gained momentum. House Democratic leaders have set a goal of reducing military spending by about twice as much as proposed by the President.⁷² They want a 6 percent decline as opposed to the 3 percent decline in spending as outlined in the five year Pentagon defense plan.⁷³ For the 1993 defense budget alone, House Armed Services Committee Chairman Les Aspin (D-Wis.) recommended cuts of \$12 to \$15 billion as compared to the \$7 billion savings outlined by President Bush in his revised budget plan.⁷⁴

The technology is not available today to resolve the fratricide issue with absolute certainty. Moreover, this advanced

technology is very expensive. For example, the total funding requirements for the technology base programs for FY92-FY99, as outlined in the Army's Combat Identification Program, total \$114 million. So far, only \$30 million have been funded.⁷⁵

The services have other critical systems and requirements that will provide strong competition to their anti-fratricide materiel programs. But if the services are indeed serious about the friendly fire problem, then they will need to make some serious joint decisions about their future program prioritization and funding.

CONCLUSION

United States military forces are some of the best, if not the best, trained and equipped fighting forces in the world. Leadership, likewise, is unequivocally superb. Yet, regardless of these strengths, fratricide continues to be an increasingly bitter statistic of today's highly fluid and lethal battlefields.

As stated in the introduction, technology that could help to identify friend from foe in a confusing combat environment has not kept pace with today's arsenal of high-tech weaponry. Although the Army and Air Force have identified many fixes for this problem, more can and should be done. Accordingly, the following recommendations are offered:

1. The Army must continue its progress in combat identification through implementation of its Combat Identification Program. History proved once again in Operation Desert Storm that

antiquated vehicle marking devices, such as colored panels and painted designs, are insufficient, especially on a high-tech 24 hour battlefield. The Army needs to field adequate identification devices now, not 15 years from now.

2. In light of compatibility problems between the Army's Tacfire Net and the Air Force's TARN, the two services should jointly pursue any future communications hardware programs. It does neither service any good to fund and field their own communications systems, only to discover later down the road that they are not compatible.

3. The Army and Air Force should jointly pursue a program to add instrumentation, such as the MILES equipment, to Air Force CAS aircraft participating in training exercises at NTC. This will permit CAS pilots to accurately track their fire and should, therefore, enable both ground and air forces to improve precautions against fratricide.

4. The Air Force must fund a program to put GPS receivers in the A-10. There will be many future instances, as there were in Operation Desert Storm, where A-10s would work a target area without FAC control. Therefore, the plan to put GPS capability only in the OA-10 FAC aircraft is insufficient.

5. Likewise, the Air Force should put the AHS in the A-10, not just in the F/A-16 and OA-10 as currently planned. One reason is the same I previously mentioned. There will be times when A-10s will operate autonomously in a target area and would definitely benefit from the AHS. But even if an OA-10 and A-10s were working

a target together, without ATHS in the A-10s, the FAC would have to pass the nine-line briefing over the radio, which is what the ATHS was designated to avoid.

6. The Air Force must reevaluate its decision to cancel the Mk XV IFF program. The existing Mk XII system will soon become obsolete and without a new cooperative IFF system to compliment the evolving NCTR systems, the USAF will be putting all of its eggs in one basket. Remember, NCTR systems used by Coalition fighters in Operation Desert Storm would not have been able to differentiate whether a Mirage F-1 fighter was Saudi, French, or Iraqi. Therefore, NCTR by itself will not completely solve the IFF problem, and a complimentary mix of cooperative and noncooperative systems is required.

7. The Army and Air Force should jointly pursue positive identification systems to aid aircraft in determining friend from foe on the battlefield.

Advanced technology solutions for fratricide are expensive and will certainly meet strong competition from other critical systems and requirements. However, the services must continue to keep these solutions in the forefront when developing requirements for weapon systems and should incorporate anti-fratricide technology into future designs.

Furthermore, it must be remembered that even with the most advanced identification systems a human being still has to operate them. Therefore, it is training coupled with technology that will ultimately reduce fratricide. The best equipment, with untrained

and undisciplined personnel, can not accomplish its mission. The new technology will enhance the prevention of fratricide, provided the soldiers, sailors, and airmen are adequately trained and the operation is properly planned, coordinated, and executed.

The bottom line is that fratricide is not acceptable. All reasonable measures must be taken to minimize the occurrence of incidents like the ones described throughout this paper. But we must understand that the "fog of war," human error, and materiel failure will make some incidents of fratricide impossible to totally eliminate. Combat leaders must, therefore, balance risk against mission accomplishment to insure quick decisive victory with minimum casualties.

ENDNOTES

¹Douglas Jeb1, "War Analysts Delving Into What Went Wrong," Los Angeles Times, 24 March 1991, 1.

²John Lancaster and Barton Gellman, "Breakthrough to Avert 'Friendly Fire' in War Is Years Away, Army Says," Washington Post, 13 December 1991, A10.

³Ibid.

⁴Casey Anderson, "Horner Underscores Tragedy of Friendly Fire," Air Force Times, 3 June 1991, 24.

⁵LTC Charles R. Shrader, USA, Amicide: The Problem of Friendly Fire in Modern War (Fort Leavenworth, Kansas: Combat Studies Institute, U.S. Army Command and General Staff College, December 1982), 40.

⁶Ibid.

⁷Ibid., 40-41.

⁸Ibid.

⁹Ibid.

¹⁰Ibid.

¹¹Ibid.

¹²Ibid., 42.

¹³Ibid., 43.

¹⁴Ibid., 55.

¹⁵Ibid., 58-59.

¹⁶Stewart M. Powell, "Friendly Fire," Air Force Magazine, December 1991, 61.

¹⁷Ibid.

¹⁸Julie Bird, "15 Possible 'Friendly Fire' Cases Investigated," Air Force Times, 19 August 1991, 6.

¹⁹Bird, 6.

²⁰Powell, 61.

²¹Ibid.

²²Ibid.

²³Ibid.

²⁴Shrader, 2.

²⁵Ibid.

²⁶Ibid., 85-86.

²⁷Ibid.

²⁸Ibid., 96-97.

²⁹Ibid.

³⁰Ibid., 98-99.

³¹Ibid., 100.

³²U.S. Department of the Army. Briefing: Operation Desert Storm Battle Damage and Friendly Fire Assessment (Fort Monroe, Virginia: U.S. Army Training and Doctrine Command, 5 July 1991), 15-16 (hereafter referred to as "TRADOC Briefing").

³³Ibid., 12.

³⁴Steve Vogel, "Hell Night," Army Times, 7 October 1991, 15-16, 18.

³⁵Caleb Baker, "War Friendly Fire Prompts U.S. Call for Doctrine Shift," Defense News, (9 December 1991): 53.

³⁶Shrader, 66.

³⁷Ibid.

³⁸Ibid., 70-71.

³⁹Norman Friedman, Desert Victory (Annapolis, Maryland: Naval Institute Press, 1991), 188.

⁴⁰Ibid., 188-189.

⁴¹"Gulf Forces Lacked Means to Avoid Friendly Fire," The Sentinel, 13 December 1991, A8.

42Ibid.

43John F. Morton, "DARPA, Industry Fielded Antifratricide Device in 19 Days," Armed Forces Journal International (May 1991): 58.

44Ibid.

45U.S. Department of the Army, Information Paper: Position/Navigation (Global Positioning System), (Colorado Springs: U.S. Army Space Command, 30 August 1991).

46Gen. Donald J. Kutyna, USAF, "The State of Space," Defense Issues, (Washington D.C.: American Forces Information Services, 23 April 1991), 5.

47Ibid.

48Ibid.

49Friedman, 189.

50David Brinkman, "Looming Crisis Over IFF," Jane's Defence Weekly, 31 August 1991, 367.

51Cmdr. George Cornelius, USN (Ret.), "Combat Resurrects Allied Identification Pressures," Signal, (May 1991): 141.

52A.L. Murray-Rochard and P.D.E. Chase, "The Future NATO Military Identification System," Military Technology (November 1988): 88.

53Brinkman, 367.

54Glen W. Goodman, Jr., "Air Force Leaves Mk XV Industry Partners Twisting in the Wind," Armed Forces Journal International (May 1991): 58.

55Powell, 62.

56Major Tom Ruiz, USA, "Green Flag," Air Defense Artillery (January-February 1990): 30.

57Baker, 53.

58U.S. Department of the Army, Combat Identification Program Interim Report, (Fort Monroe, Virginia: U.S. Army Training and Doctrine Command, 12 December 1991), 3-4 (hereafter referred to as "TRADOC Combat ID Report").

59Ibid., D4-D5.

⁶⁰Baker, 53.

⁶¹Eric Schmitt, "U.S. Seeks to Cut Accidental War Death," The New York Times, 9 December 1991, A12.

⁶²TRADOC Combat ID Report, D1.

⁶³Ibid.

⁶⁴Ibid.

⁶⁵Ibid., D6.

⁶⁶Powell, 63.

⁶⁷Jay C. Lowndes, "Cooperative Attack," Air Force Magazine, November 1991, 60.

⁶⁸Ibid., 62-63.

⁶⁹Julie Bird, "More GPS, Better Vehicle ID Urged," Air Force Times, 26 August 1991, 13.

⁷⁰Joris Janssen Lok, "Infra-Red May End 'Blue-on-Blue'," Jane's Defence Weekly, 13 July 1991, 50.

⁷¹R.W. Apple, Jr., "Battle Cry In Congress," The New York Times, 1 October 1991, A10.

⁷²Rick Maze, "Democrats Urge 40% Cut In U.S. Military In 5 Years," Air Force Times, 21 October 1991, 18.

⁷³Ibid.

⁷⁴John Lancaster, "Aspin Seeks to Double Bush's Defense Cuts," Washington Post, 27 February 1992, A16.

⁷⁵TRADOC Combat ID Report, D44.

BIBLIOGRAPHY

- Almond, Peter. "American Pilots Apologize for Gulf 'Friendly Fire' Deaths." The Daily Telegraph, 26 July 1991, 4.
- Anderson, Casey. "Horner Underscores Tragedy of Friendly Fire." Air Force Times, 3 June 1991, 24.
- Apple, R.W., Jr. "Battle Cry In Congress." The New York Times, 1 October 1991, A10.
- Baker, Caleb. "War Friendly Fire Prompts U.S. Call for Doctrine Shift." Defense News (9 December 1991): 4, 53.
- Barrow, Captain Robert F., USA. "A2 C2 the Air Defender's Role." Air Defense Artillery (March-April 1990): 6-11.
- Bird, Julie. "AF, Army Developing Combat ID Systems." Air Force Times, 23 December 1991, 4, 17.
- _____. "15 Possible 'Friendly Fire' Cases Investigated." Air Force Times, 19 August 1991, 6.
- _____. "Friendly Fire: Deadly Mistakes in U.S. Air Attacks Studied for Solutions." Air Force Times, 26 August 1991, 12, 16, 18.
- _____. "JCS Push for Vehicle IDs Is Called Political." Air Force Times, 9 September 1991, 25.
- _____. "More GPS, Better Vehicle ID Urged." Air Force Times, 26 August 1991, 13.
- Bird, Julie and Tom Donnelly. "Friendly Fire." Army Times, 19 August 1991, 3.
- Brinkman, David. "Looming Crisis Over IFF." Jane's Defence Weekly, 31 August 1991, 367-368.
- Coombs, Leslie. "Electronic Warfare: The Role of IFF." Military Technology (May 1988): 55-59.
- Cornellius, Cmdr. George, USN (Ret.). "Combat Resurrects Allied Identification Pressures." Signal (May 1991): 140-147.
- Daub, Captain Leo, USAF. "Airspace Coordination Areas (ACA)-A CAS Pilot's Perspective." USAF Fighter Weapons Review (Spring 1990): 5-9.

- Eldridge, Bo. "Desert Storm: The Mother of All Battles." Command Magazine, November-December 1991, 26-43.
- Friedman, Norman. Desert Victory. Annapolis, Maryland: Naval Institute Press, 1991.
- Goodman, Glenn W. Jr. "Air Force Leaves Mk XV Industry Partners Twisting in the Wind." Armed Forces Journal International (May 1991): 58.
- "Gulf Forces Lacked Means To Avoid Friendly Fire." The Sentinel, 13 December 1991, A8.
- Jeb1, Douglas. "War Analysts Delving Into What Went Wrong." Los Angeles Times, 24 March 1991, 1.
- Johnson, Robert and Caleb Solomon. "Chilling Tapes Show How Soldiers Died in 'Friendly Fire'." The Wall Street Journal, 7 November 1991, A1.
- _____. "Gulf War Casualty." The Wall Street Journal, 10 September 1991, A1.
- Kutyna, Gen. Donald J., USAF. "The State of Space." Defense Issues. Washington, D.C.: American Forces Information Service, 23 April 1991, 1-8.
- Lancaster, John. "Aspin Seeks to Double Bush's Defense Cuts." Washington Post, 27 February 1992, A16.
- Lancaster, John and Barton Gelman. "Breakthrough to Avert 'Friendly Fire' in War Is Years Away, Army Says." Washington Post, 13 December 1991, A10.
- Lok, Joris Janssen. "Infra-Red IFF May End 'Blue-on-Blue'." Jane's Defence Weekly, 13 July 1991, 50.
- Lowndes, Jay C. "Cooperative Attack." Air Force Magazine, November 1991, 60-64.
- Maze, Rick. "Democrats Urge 40% Cut in U.S. Military in 5 Years." Air Force Times, 21 October 1991, 18.
- "Mistaken Identity Accounts for Worst 'Friendly Fire'." The Sentinel, 17 September 1991, A6.
- Morton, John F. "DARPA, Industry Fielded Antifratricide Device in 19 Days." Armed Forces Journal International (May 1991): 58-60.
- Murray-Rochard, A.L. and P.D.E. Chase. "The Future NATO

Military Identification System." Military Technology
(November 1988): 88-91.

Powell, Stewart M. "Friendly Fire." Air Force Magazine,
December 1991, 58-63.

Ruiz, Major Tom, USA. "Green Flag." Air Defense Artillery
(January-February 1990): 28-33.

Schmitt, Eric. "U.S. Seeks to Cut Accidental War Death." The New York Times, 9 December 1991, A12.

Shrader, LTC Charles R., USA. Amicide: The Problem of Friendly Fire in Modern War. Fort Leavenworth, Kansas: Combat Studies Institute, U.S. Army Command and General Staff College, December 1982.

U.S. Department of the Army. Briefing: Operation Desert Storm Battle Damage and Friendly Fire Assessment. Fort Monroe, Virginia: U.S. Army Training and Doctrine Command, 8 May 1991.

U.S. Department of the Army. Combat Identification Program Interim Report. Fort Monroe, Virginia: U.S. Army Training and Doctrine Command, 12 December 1991.

U.S. Department of the Army. FM 6-20: Fire Support in Combined Arms Operations. December 1984.

U.S. Department of the Army. Information Paper: Position/Navigation (Global Positioning System). Colorado Springs: U.S. Army Space Command, 30 August 1991.

U.S. Department of the Army. White Paper: Doctrine, Tactics, Techniques, and Procedures for Clearance of Indirect Fires. Fort Sill, Oklahoma: U.S. Army Field Artillery School, 31 December 1991.

Vogel, Steve. "Hell Night." Army Times, 7 October 1991, 8, 14-16, 18, 24, 69.

_____. "VII Corps Soldiers Describe Incidents." NY Times, 19 August 1991, 3-4, 11.

Wiltse, Captain Jeffrey S., USA. "Training to Prevent Fratricide." Armor (July-August 1991): 46-48.