The Battlefield Combat Identification System:

A Task Force XXI Response to the Problem of Direct Fire Fratricide

by Captain Chad Jones

The first requirement in warfare is the ability to distinguish friend from foe.[1]

-Recognition Pictorial Manual, FM 30-30 [June 1943]

Fratricide, a problem as old as warfare itself, is a complex issue that defies simple solutions. Defined as the employment of friendly weapons and munitions with the intent to kill the enemy or destroy his equipment or facilities, that results in unforeseen and unintentional death or injury to friendly personnel. Fratricide is a grim fact in combat operations. [2]

As the latest version of FM 17-15 [*Tank Platoon*] points out, the accuracy and lethality of modern weapons systems make it possible to engage and destroy targets at unprecedented ranges. At the same time, the ability of U.S. forces to acquire targets using conventional daylight and thermal imagery often exceeds the ability to accurately identify targets as friend or foe. As a result, friendly elements can be engaged unintentionally and destroyed in a matter of seconds.[3]

During Operation Desert Storm, direct fire engagements accounted for 12 of the Army's 15 total incidents of fratricide. The numbers of casualties these incidents represent are sobering: of 615 total soldiers either wounded or killed in action, 107, or 17 percent, were the result of friendly fire. Thirty-five American soldiers were tragically killed; another 72 were wounded because one friendly vehicle opened fire on another.

Of these 12 incidents, 11 occurred at night. Ten are believed to have occurred at ranges of less than 1500 meters. Almost all were characterized by reduced visibility. The effects of rain, dust, smoke, and fog, coupled with the vast distances American forces traveled over Southwest Asia's often featureless desert terrain, were also clearly contributing factors. "On the unrestricted desert battlefield, direct fire lethality far outstripped [a] gunner's ability to achieve positive target identification." Studies suggest that the decision to fire was based largely on the tank commander's and gunner's perception of where they and other friendly forces were located with respect to a given target. "This situational awareness, dependent upon planning and control measures, [is] key in understanding Desert Storm fratricide incidents."[4]

For the last ten years, the Army's CTCs have routinely tracked incidents involving fratricide. The RAND Corporation conducted a study in 1986 that examined 83 direct-fire battles executed by 15 different task force-sized units. Among its conclusions, the study reported that most of the direct fire fratricides were isolated incidents involving single vehicles during one engagement. Of the few incidents involving multiple engagements, 75 percent occurred in darkness. In addition, Rand found that over half of the firing vehicles could have avoided fratricide had they known the location of their sister units. Another 33 percent would have needed to know the location of isolated friendly vehicles not in contact with the enemy. The remaining 16 percent would have required an IFF device to distinguish friendly vehicles intermixed with the enemy.[5]

A similar study, conducted by the Center for Army Lessons Learned [CALL] and the Army Research Institute [ARI], used computer records from 1986-1990 to show that in certain conditions, as many as 11 percent of total attempted direct-fire engagements were fratricidal. This study concluded that "the average self-inflicted toll at the NTC... may be as high as two to three combat vehicles" per mission.[6]

Causes of Direct Fire Fratricide

There is no simple explanation for direct-fire fratricide. Immediately following the Persian Gulf War, General Gordon Sullivan, then Army Vice Chief of Staff and later Army Chief of Staff, directed TRADOC and the Army Material Command [AMC] to examine the causes and find potential solutions to the problem. The TRADOC-AMC task force on combat identification identified more than 200 different potential solutions spanning doctrine, training, leader development, organizations, material, and soldier support, but focused on two:

- *Situational Awareness* (SA). The real-time accurate knowledge of one's own location and orientation, as well as the locations of friendly, enemy, and noncombatant elements. SA includes awareness of the METT-T conditions that affect the operation.
- *Positive Identification.* The immediate, accurate, and dependable ability to discriminate through-sight between friend and foe. This ability must extend to maximum acquisition and engagement ranges, and cannot increase vulnerability or decrease system performance. Finally, positive identification must occur reliably in all light and weather conditions and take into consideration all battlefield effects.

In its conclusion, the task force noted that these two factors; the "lack of positive target identification and the inability to maintain situational awareness in combat environments," are the major contributors to fratricide. "If we know where we are and where our friends are in relation to us, we can reduce the probability of fratricide. If, in addition, we can distinguish between friend, neutral, and enemy, we can reduce that probability even more" [TRADOC-AMC Combat Identification Interim Report].[7]

The Battlefield Combat Identification System [BCIS]

Enter BCIS, one of the initiatives designed to prevent fratricide that was recently tested at the National Training Center. Part of the Army's Advanced Warfighting Experiment, the Battlefield Combat Identification System [BCIS] is designed to immediately identify potential targets as friendly, enemy, or neutral/noncombatant. BCIS is an all-weather, digitally-encrypted question and answer system developed by TRW Space and Electronics Group for the Army's Communications and Electronics Command.

The system has been described by proponents as "the long-distance equivalent of 'Halt! Who goes there?'." BCIS queries a potential target with a 38-GHz electronic millimeter wave pulse. Fully integrated into the platform's fire control system, BCIS is largely transparent to the vehicle's crew. After aligning the

COLOR	INDICATION		MEANING
	AUDIO	VIDEO	
M1A1 ABRAMS TANK			
Yellow	NA	Flashing	Friend
Yellow	NA	Constant	Unknown
M2A2 BRADLEY IFV			
Red	Pulsing 666Hz	Flashing	Friend
Yellow	Warbling 455/666 Hz	Constant	Unknown

Figure 1. BCIS Indicators by Platform Type

weapon's sights on a potential target, the gunner activates BCIS by using the vehicle's laser rangefinder [M1A1 Tank], or by pressing an interrogation switch mounted just below the vehicle's trigger [M2A2 Bradley]. If also equipped with BCIS, the potential target responds with a signal of its own. Vehicles not responding are characterized as unknown. Whichever the response, the answer to the query is displayed in less than one second as a visual signal in the gunner's sight. At the same time, an audio tone is transmitted through the firing platform's intercom, and is heard by each member of the crew. If equipped with BCIS, a distinct tone is also heard by the crew members of the potential target, informing them that they are being interrogated. [See Figure 1 - BCIS Indicators by Platform Type.]

Each interrogation is the sum of three queries. In under a second, the system issues three separate pulses and analyzes three separate responses before displaying the status of a potential target. This triple redundancy allows for an accuracy rate of above 97 percent. The system transmits only when interrogating or responding. Built-in features prevent detection, jamming, or interception by enemy electronic warfare assets. Signal encryption occurs via a COMSEC variable and is loaded utilizing a standard KYK-13 COMSEC fill device. Frequency hopping, where the frequency changes a minimum of 43 times during the one second interrogation and response cycle, and specialized waveforms, practically eliminate the possibility of detection. The entire cycle is summarized in the eight steps listed below:

- Gunner presses laser rangefinder or interrogation button
- BCIS transmits message containing platform ID via interrogator antenna
- Target receives message via transponder antenna
- Target BCIS validates message
- Target BCIS responds with interrogator's ID and own ID
- Target platform operators are informed of query
- Interrogator validates message
- Results of interrogation displayed in gunner's sight ring

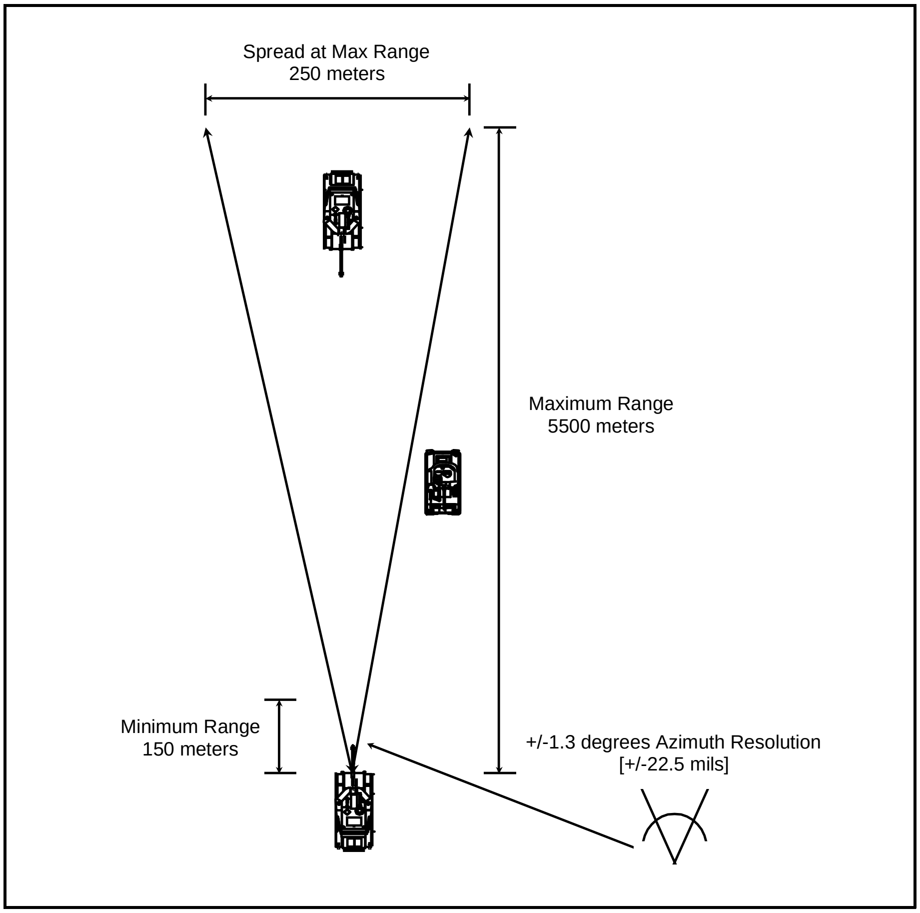

Figure 2. Interrogation Range Pattern

BCIS is effective in all visibility conditions. The system ranges from 150 meters to 5500 meters at elevations between -10 degrees and + 40 degrees; and from 150 meters to 2750 meters at elevations between +40 degrees and +50 degrees. As shown at left, the interrogator has +1.3 degrees, or +/- 22.5 mils of discrimination. When activated, the BCIS interrogator emits a millimeter wave beam, baffling out from the interrogator in the shape of a cone, that increases 45 meters in width for every 1000 meters traveled. At 5500 meters, the wave baffle is 250 meters wide. [See Figure 2 - Interrogation Range Pattern.]

The system is also effective in all types of weather conditions and battlefield effects, though maximum ranges are affected as identified below:

Maximum Effective Range	Weather Condition
5500 meters	Clear Sky
5500 meters	Fog Oil
5000 meters	Dust
4000 meters	Radiation Fog
3000 meters	Steady Rain

Figure 3. Maximum Ranges vs. Weather Conditions

BCIS has an additional feature unique to Task Force XXI vehicles: the ability to provide accurate situational awareness information. In field trials conducted in June 1995, a TRW team successfully demonstrated that BCIS could be configured to send, receive, and display friendly position information about other BCIS-equipped vehicles on the battlefield. This digital data link [DDL], not part of the Army's original BCIS requirement, was implemented using no new hardware and one piece of new software.

When a BCIS/DDL-equipped shooter interrogates another BCIS/DDL platform, the target platform responds automatically by transmitting a covert, digital signal from its omni-directional antenna. This occurs in conjunction with the 38-GHz electronic millimeter wave pulse that carries the anti-fratricide information. The signal contains the target vehicle's global positioning system [GPS] coordinates and an identification code unique to that platform. The shooter adds this information to its own display, an appliqué computer screen showing a digitized map, digital graphics, and the location of friendly icons. It then transmits a composite signal that shows the GPS location of all known BCIS/DDL platforms within the area.

The composite signal is retransmitted several times per minute through the BCIS omni-directional antenna. Any BCIS/DDL platform within a one kilometer radius will receive this situational awareness information, update its display, and retransmit its own composite signal. The presence of multiple BCIS/DDL platforms transmitting position and identification data in parallel allows situational awareness to spread rapidly across the battlefield, even to those systems not directly involved in the interrogation sequence.[8]

System Components

BCIS is composed of an interrogator subassembly, a transponder subassembly, an antenna, a processor and display unit, and the sight ring indicators.[9] The complete system is installed on vehicles designated as "shooter" platforms, primarily tanks and Bradleys. A transponder-only system, consisting of an antenna and processor display, is used on "non-shooter" platforms.

The Transponder Antenna. The transponder antenna is an omni-directional antenna mounted at the end of a 3-foot mast. When installed, a heavy spring at the base provides impact resistance during collisions with obstacles. The radome, at the tip of the antenna, is elevated from the platform to provide a maximum field of view for receiving and responding to queries from interrogating platforms.

Receiver-Transmitter Group. The receiver-transmitter group processes the interrogation data for the internal transmitter. It transmits the encrypted interrogation and receives encrypted replies from other friendly BCIS-equipped platforms. The R-T group is mounted inside an armored housing that provides environmental and limited [7.62 mm and smaller] ballistic protection.

Interrogator Antenna. During the interrogation cycle, the interrogator antenna is used for the transmission of the millimeter wave signal, and the reception of the transponder reply. Approximately 12 inches in length, it is coaxially mounted on the firing platform's gun tube. Like any weapons system, it must be boresighted to achieve maximum effectiveness.

Interface Unit [BCIS Control Box] and Interconnecting Box. The BCIS control box provides a majority of the BCIS operator's controls and indicators. It generates the required regulated DC voltage and routes it to the various circuits and subassemblies in the BCIS system. It provides COMSEC and TRANSEC capability and interface. It controls and passes data to and from the R-T Group. And, it performs conventional encoding and decoding and error detection. The interconnecting box provides the interface between BCIS and the rest of the platform. Mounted just below and attached to the control box, it connects to the vehicle intercom, laser rangefinder or interrogator switch, platform ID, PLGR, sight ring, and appliqué.

Sight Ring Indicators. Mounted on the gunner's eyepiece, the sight ring indicators superimpose BCIS symbology onto the gunner's sight. The Bradley sight ring indicators consist of two LEDs, one yellow and one red. These lights rotate with the diopter ring as the gunner focuses his Integrated Sight Unit [ISU] and may turn up to 300 degrees. The M1A1 Abrams indicator consists of one yellow LED, located to the left of the range readout. [See Figure 4 - Sight Ring Indicators.]

Outfitting the Army's Experimental Force

Task Force 3-66 Armor, one of the two balanced task forces in the Army's EXFOR, was outfitted with BCIS in the Spring of 1996. Forty-four shooter platforms were distributed among two tank and two mechanized company teams. Each had a total of eleven systems, three in each platoon, one installed on the XFIST Bradley, and one installed on either the company team commander's tank or Bradley, or company team executive officer's tank or Bradley. Ten additional non-shooter systems were installed on each of the task force's scout platoon HMMWVs. Eight more were installed on an assortment of engineer and chemical support vehicles: three on M93 FOXs, two on M113 personnel carriers, and three on M9 ACEs. In total, the task force had 62 BCIS systems.

New Equipment Training [NET], created and implemented by representatives

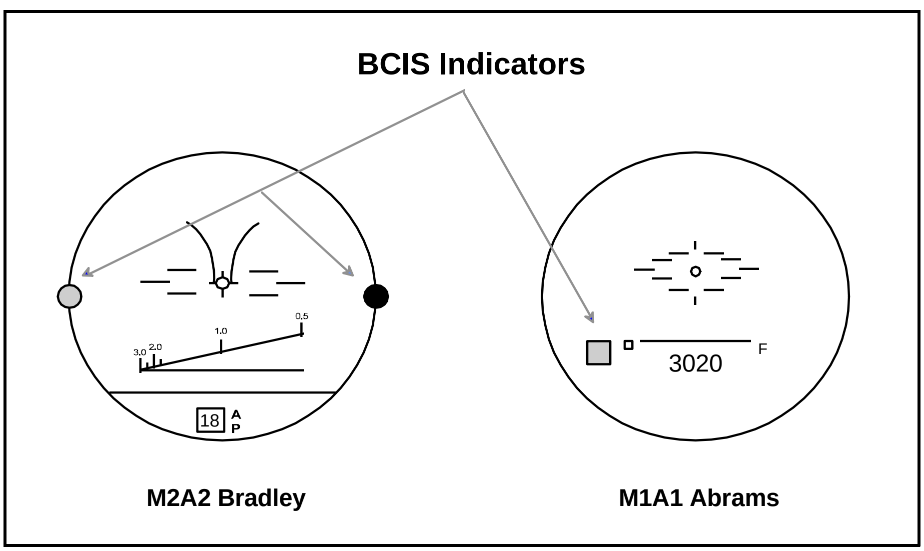

Figure 4. Sight Ring Indicators

from TRW, began shortly after instrumentation. It consisted of a four-hour block of classroom training, and focused on topics ranging from theory and hardware descriptions to PMCS and troubleshooting. Classroom training culminated with a written exam. Four additional hours of hands-on training was conducted by each soldier on the platform he would ultimately fight on.

After a series of unit-level functionality experiments, Task Force 3-66 Armor put BCIS to the test during a series of maneuver training exercises. Platoon lane training was conducted for almost four weeks in August and September of 1996, company lane training for two weeks in October, and task force exercises for two weeks in December. Throughout, BCIS was utilized with steadily improving accuracy and effectiveness. Beginning in February 1997, all 62 BCIS systems were transported to the National Training Center for evaluation as part of the Army Warfighting Experiment conducted throughout March 1997.

Performance

Overall, BCIS performed very well, and largely as advertised. Though specific performance data has yet to be released, TF 3-66 Armor experienced countless instances where BCIS prevented direct fire fratricide. Counterreconnaissance elements were routinely interrogated during periods of limited visibility to confirm that no enemy vehicles had compromised their formations. Assaulting elements were often interrogated by the support force as they became intermingled with the enemy on friendly objectives. Scout HMMWVs, which at extended ranges resemble enemy (OPFOR) BRDMs, were effectively interrogated while occupying screen line OPs or while displacing behind friendly lines. The list goes on and on.

Like any system, BCIS had particular strengths and weaknesses. On the positive side, it was extremely durable: the system's operational readiness rate exceeded 95 percent throughout the train-up and rotation. Timeliness was also a plus. As advertised, BCIS added no noticeable lapse in the target acquisition — engagement sequence. When an M1A1 tank gunner activated his LRF, he simultaneously activated the BCIS. If also equipped with BCIS, the potential target vehicle responded to the interrogation and results were displayed in the gunner's sight ring and over the intercom; all in under a second. BCIS was also accurate. When properly boresighted, the system displayed reliable interrogation results at ranges up to 5000 meters, in a variety of light and weather conditions and battlefield effects.

It was nearly impossible to determine the effectiveness of the digital data link. Each vehicle's appliqué, operating independently, provided extremely effective situational awareness over distances far greater than BCIS's maximum effective ranges. In addition, friendly icons on a vehicle's display were identical for BCIS/DDL and appliqué generated data. Still, BCIS's DDL did provide some redundancy when the appliqué did not function properly.

There were also several weaknesses. Systems would occasionally dump the COMSEC fill, a problem caused by the short duration of the BA 5372/U lithium "keep-alive" memory battery. Projected to last for up to six months, the battery often failed in under a week. In addition, BCIS was not compatible with the Automated Net Control Device [ANCD], the COMSEC fill device used for all other Task Force XXI equipment: BCIS required the less reliable KYK-13 fill device. And, though an artificiality of the experiment, BCIS's effectiveness was reduced by the fact that not every vehicle was instrumented with the system. The most important weakness, however, was the inaccuracy caused by BCIS's wave baffling effect. During the close fight, when friendly vehicles became intermingled with enemy vehicles, BCIS's effectiveness was limited. This problem was magnified at greater ranges, when visual identification was impossible, and where the effect of the baffle was more prominent. At 5000 meters, if a BCIS equipped friendly platform was within 250 meters of the enemy, and a gunner interrogated that enemy vehicle, he would receive a friendly indicator.

Despite its shortcomings, the bottom line for BCIS is extremely encouraging: throughout the train-up and during eight missions conducted over two weeks in the box, TF 3-66 Armor experienced no direct fire fratricide involving those systems equipped with BCIS.

Conclusion

"The modern battlefield is more lethal than any in history. The pace of operations is rapid and the non-linear nature of the battlefield creates command and control challenges for all unit leaders."[10] Technology by itself will never provide the sole means for the prevention of direct fire fratricide. Crew discipline, situational awareness, and challenging, realistic training designed to ensure the rapid acquisition and positive identification of potential targets remains the first and best means of preventing friendly fire.

As advances in technology push the envelope in target acquisition and engagement ranges, however, tank and Bradley crews will need technological assistance to take advantage of this improved lethality while still preserving the force. The Battlefield Combat Identification System is one system that has proven its worth for use by soldiers in the Army of the 21st Century.

Notes

[1]*Recognition Pictorial Manual,* War Department Field Manual 30-30 [June 1943] p. 1.

[2]FM 17-15, *Tank Platoon*. Headquarters, Department of the Army [April 1996] p. F-1.

[3]FM 17-15, *Tank Platoon,* p. F-1.

[4]*Fratricide: Reducing Self-Inflicted Losses.* Center for Army Lessons Learned [CALL], No. 92-4 [April 1992] p. I-1.

[5]*Fratricide: Reducing Self-Inflicted Losses*, p. I-1.

[6]*Fratricide: Reducing Self-Inflicted Losses*, p. II-1.

[7]*Ibid.*

[8]Associated Press Release, Redondo Beach, Calif., [August 2, 1995].

[9]TM 11-5895-1554-10, *Battlefield Combat Identification System*, Headquarters, DA [1 June 1996] p. 1-9.

[10]FM 17-15, *Tank Platoon,* p. F-1.

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