



# Artillery Surveyors Nomads of the Battlefield

by Chief Warrant Officer Three W. Mark Barnes, USMC

**I**n the old days, determining the accurate location of artillery batteries and target elements so units could mass fires was the arduous task of the artillery surveyor—on foot with transits, aiming circles, tapes and slide rules. The magnitude of the effort was directly proportional to the number of units present, size and topography of the area of operations, the nature of the operations and the extent and accuracy of existing survey control.

Survey teams were nomads on the battlefield, operating during the day without higher level supervision and coming home at night to tell what they had done (and seen) and determine where they were needed for the next day. If their units were able to mass fires, then they had done their job.

Today we put no more thought into having survey data available than we do into turning on a light switch. We have instant electronic position locating devices, such as the global positioning system (GPS).

Due to advances in technology and personnel cuts, the modern surveyor may be on the verge of extinction. Some proposals get rid of the surveyor altogether while others suggest integrating survey functions into another military occupational specialty (MOS). But before the FA decides to do away with or integrate this nomad with other MOS, we must understand the impact of this decision on the artillery community.

This article discusses the training for today's surveyors, the difficulties with the Marine Corps surveyors' career development assignments and the dangers of relying on new GPS-aided devices for primary position location because those systems are so easily defeated. I propose units train more to prepare for position location device failures and that we do not eliminate our surveyor MOS until our devices are more robust and reliable on the battlefield.

**Training and Developing the Surveyor.** The modern artillery surveyors

are MOS 82C (Army) and MOS 0844 (USMC). Both MOS have unique skills and training to ensure survey data is available to their firing units in any situation.

There are some major differences between how the Army and the USMC develop their survey personnel. However, both services have proposals to downsize or do away with their surveyors that could negatively impact US artillery capabilities.

The Army 82C spends seven weeks at the FA Training Center, Fort Sill, Oklahoma, for his advanced individual training (AIT). He receives training on a multitude of tasks, to include operating the T-16 theodolite, astro (azimuth using stars and sun) and position and azimuth determining system (PADS).

The remainder of the 82C's instruction is on applying his newly learned survey skills. His sole responsibility is survey until he becomes a 13Z master sergeant. Along the way, he attends the basic and advanced NCO courses (BNOC and ANOC) and receives additional survey training. Currently the Army only has about 800 82Cs.

In contrast, the Marine 0844 receives different training and career development than the Army 82C. The 0844 starts his career as a 0844 fire direction controlman, spending eight weeks at Fort Sill learning manual and automated gunnery. After graduating, 99 percent of the 0844s report to the fleet marine force (FMF) where they work in battery fire direction centers (FDCs) as the equivalent of an Army MOS 13E Cannon Fire Direction Specialist. Approximately one percent of these graduates stay at Fort Sill to attend the Marine Survey Course.

The four-week Marine Survey Course is similar to its Army counterpart, but it is not MOS-producing. Its content covers different equipment, with the exception of PADS, which both services have.

Every artillery battalion and regiment has a survey section; optimally, the 0844s rotate through survey section and FDC billets. The challenge occurs when, due to an operational necessity, a first-tour surveyor does not rotate into a battery FDC—yet is expected to be experienced in fire direction when he becomes a staff sergeant FDC chief. This creates a problem because the individual is expected to be qualified on multiple tasks with limited time and resources to learn them and maintain his proficiency.



Both Army and Marine Corps surveyors use PADS.

When the 0844 becomes a staff sergeant, he attends the Marine Operations Chief Course (MAOCC) and becomes an operations chief (MOS 0848). The 0848 acts as a survey chief, operations chief, radar employment chief, meteorology chief or even an 81-mm mortar platoon sergeant with an infantry battalion.

The Marine Corps achieves such flexibility of the 0844 based on the expertise of the warrant officer (0803) in each survey section. The WO 0803 is the technical expert in survey, radar and Met and ensures quality control and the movement of people to spread experiences—a challenge with the wide variety of training and experience of the individuals serving in the positions.

Although each service has its own way of training surveyors, the surveyors' mission and expertise are critical to the operations of every US artillery unit. Before we eliminate these essential members of our team, we must understand how vulnerable the new position location devices are and the impact of their failure on the accuracy of our firing units. The systems we would use today for position location "instead of" using the surveyor are susceptible to defeat by the enemy.

**GPS Systems.** Probably the most significant advancement in technology threatening to eliminate the surveyor is GPS. The artillery community has put a tremendous amount of confidence into GPS technology and is counting on GPS' being available at all times, which may not be the case. Here are a few examples of current and future systems that depend on GPS to some degree.

*Improved Stabilization Reference Package (ISRP).* The GPS-aided ISRP provides north-seeking and pointing

functions as well as full three-dimensional land navigation and location capabilities for the current M270 multiple-launch rocket system (MLRS) and Army tactical missile system (ATACMS).

*Gun Laying and Positioning System (GLPS).* This is a GPS-dependent, man-portable, north-seeking gyroscope with an integrated precision lightweight GPS receiver (PLGR) capable of determining position, azimuth and deflection for quick, accurate gun-laying data for towed and non-Paladin howitzers. The GLPS is being fielded to the force with a basis of issue of one per firing battery or platoon.

*Positioning and Navigation Unit (PNU).* The PNU is a line replaceable unit (LRU) in the M270A1 MLRS and high-mobility artillery rocket system (HIMARS) launchers that will replace the M270 ISRP and position data system (PDS). The GPS-aided PNU provides launcher position and navigation data via a self-contained strap-down inertial platform system, an embedded GPS receiver module and associated GPS antenna.

*Bradley Fire Support Team (BFIST) and Striker Equipment Mission Package (EMP).* The GPS-aided BFIST/Striker EMP provides the two vehicles three-dimensional position location and azimuth, using an inertial navigation system (INS), PLGR and a vehicle measuring system (VMS).

*GPS-Dependent Precision Munitions.* In addition to these artillery systems, we are developing munitions that incorporate GPS technology to guide rounds precisely onto targets.

**GPS Vulnerabilities.** If we could be sure accurate GPS capabilities were available at all times, there would be no need for concern. But today's GPS technology has vulnerabilities that, when taken advantage of, can cause the GPS to function improperly or not at all, thereby denying users accurate position data.

Modernization efforts are ongoing to make GPS more reliable and robust, so the artillery community can use it as the sole means of receiving position data in the future. However, these improvements won't be in place for years to

come. Some of the improvements include better receivers and upgrades to the current satellite constellation.

*Jamming the GPS.* The most profound vulnerability GPS has is its susceptibility to jamming. The satellite signal strength needed for GPS operations can be compared to the strength of that a 100-watt light bulb emitting 300 miles away. In addition to the signal's being so weak, the satellite frequencies are published openly so anybody with a few hundred dollars can manufacture an inexpensive and effective jamming device. In fact, one entire industry has developed GPS jammers and will sell them to anyone who wants to buy them.

Several years ago at an air show in Russia, a company called Aviaconversia demonstrated a four-watt GPS jamming device that could jam GPS signals within a 200-nautical mile radius. The cost of this GPS jammer was \$4000 dollars. There are indications that business is booming for this company because it is on its fourth version of this device and has increased its power to eight watts. In addition to Russia, several other countries are selling GPS jammers on the open market.

Shown in the picture is a "Nestea" can that is an actual GPS jammer. This is a one-watt jammer disguised in a soda can that has an effective range of 20 to 40 nautical miles. This device easily could be scattered throughout the battlefield, thereby denying US forces the use of GPS.

*Spoofing the GPS.* "Spoofing" is the ability to record the GPS signal and, at a later time, re-transmit those same signals at a higher power, introducing position errors. Because this signal is transmitted at a higher power, users receive



This one-watt jammer disguised in a soda can has an effective range of 20 to 40 nautical miles.

the spoof signal and are not aware the data is old and inaccurate.

Military users who have crypto fill loaded in their GPS receivers make those GPS hard to spoof. But as spoofing technology advances, we have cause for concern. The international military industry is working on means to spoof our currently protected military receivers.

**Training to Compensate for Vulnerabilities.** With these vulnerabilities, the artillery community may be relying too heavily on GPS technology to accomplish the mission. A good example of this over reliance is seen everyday in the artillery community's weak land navigation skills. It takes only a few hours to train an artilleryman to use the PLGR, but it takes several weeks for him to master map, compass and terrain association skills. The path chosen is the easier one—if not more risky.

Today, it has become more difficult to train military GPS users in the field because working with jamming affects many other civilian GPS users in the area. To train a unit in the field on degraded operations, we must coordinate extensively with many agencies outside the military. Therefore, military GPS users rarely experience GPS problems, which has led to a false sense of security among military GPS users.

To ensure their units are truly combat ready, commanders should ask themselves two questions. Is my artillery unit prepared to operate in a GPS-jammed environment? When was the last time my unit conducted basic land navigation training without GPS?

The Army has conducted limited tests to evaluate how well units perform in this environment, and some of the results should cause concern. In one case, just the threat of GPS jamming caused units not to use the GPS equipment. Subsequently lots of personnel got lost—so lost, in fact, that several elements went into an artillery impact area. What if it had been a minefield?

Units that eventually got jammed lost confidence in the equipment and put it away. Once again, due to a lack of basic land navigation skills, personnel got lost.

Another lesson learned during testing was that the enemy can jam support units and have the same defeating effect as when they jam the main forces. One tank unit had invested a tremendous amount of money in anti-jam technology to make it more difficult to jam the GPS on the tanks. But the enemy didn't attack the tanks; he jammed the logis-



Among other tasks, surveyors conduct crater analysis as CWO5 Lou Lozada does here in Beirut, Lebanon, 1983.

tics trains. The result was the tanks didn't get resupplied because the log train couldn't find them without the aid of GPS. Surveyors are trained to operate without GPS.

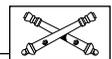
During Operation Desert Storm, the artillery community quickly found out how difficult it was to operate with several different datums. Our allied forces, different services and individual units all used their own maps or mapping systems with different datums. Zone-to-zone transformations and datum conversion weren't as easy as expected.

A surveyor can overcome the multi-datum obstacle. Envision a situation where GPS is unavailable and all the maps of the area are in geographic coordinates. The surveyor can convert the geographic coordinates to Universal Transverse Mercator (UTM) and then establish a survey control point (SCP). From this SCP, he can extend survey control to all elements, thus ensuring all are on a common grid.

Currently, there are more than 1,000 map datums identified by the National Imagery and Mapping Agency (NIMA). This agency is working to reduce all these datums to one worldwide datum, called WGS 84. Until NIMA completes this complex task, the artillery community will face the challenge of operating with different datums. Even within the US, some of our map products have not been converted to WGS 84; until the inventories of these maps are exhausted, we will need the expertise of our surveyors to convert the data.

Without proper conversion, units firing with different datums can create large errors—miss critical targets and, perhaps, endanger friendly forces.

When the GPS becomes more robust and less vulnerable and the world converts to WGS 84, then the day may come when this nomad of the battlefield will be less critical. But today, his skills are necessary to meet the five requirements for accurate, predicted fires. This nomad of the battlefield, this soldier or Marine surveyor, can provide the US artillery position data 24 hours a day, seven days a week and in any type of environment—with or without the aid of GPS.



Chief Warrant Officer Three W. Mark Barnes, US Marine Corps (USMC), has been the Officer-in-Charge of the Survey Branch of the Gunnery Department in the Field Artillery School, Fort Sill, Oklahoma, since July 1997. In his previous assignment, he was the Survey Officer for the 5th Battalion, 11th Marines at Camp Pendleton, California. Among other assignments, he served as the Radar Employment Chief attached to the 5th Battalion, 10th Marines in the Gulf during Operations Desert Shield and Storm. While stationed with the 10th Marines at Camp Lejeune, North Carolina, he was the Radar Team Leader attached to the 22d Marine Expeditionary Unit (MEU) in support of Operation Urgent Fury in Granada and, subsequently, for operations in Beirut, Lebanon. Chief Barnes first entered the Marine Corps in 1981 and will retire in April 2001.