Tactical Employment Considerations of HF Radios in the Cavalry Squadron

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There are a few misconceptions about the use of High Frequency (HF) communications in the U.S. Army today, especially in a Decisive Action Training Environment (DATE). Based on the US military's experiences in Iraq and Afghanistan with theater provided equipment, leaders assume that HF will provide the means to conduct a one-for-one exchange of a unit's typical slate of FM nets to include Command, O&I, A&L and Fires that are each operated on a separate radio. Others assume that since putting an HF radio into operation is relatively easy, units should be able to put an HF network into operation with ease. The truth is that units only have enough HF radios to establish communications between key leaders. To put them into operation in an effective HF network requires a higher level of training and understanding than units currently have. The network is what is needed for effective Mission Command. This article records the observations of Cavalry Squadron's HF use at the Joint Readiness Training Center (JRTC), illuminate why units struggle, and convey recommendations and resources for HF training at home station so units can maximize their HF capabilities for employment in a DATE scenario and prepare for potential large-scale combat operations.

Observations of Cavalry Squadron HF use at JRTC

JRTC Observer-Coach/Trainers (OC/T's) can summarize a Cavalry Squadron's HF use with just three words: not very much. We use Cavalry Squadrons as an example in this paper because they have the most HF radios on their modification table of organization and equipment (MTOE) compared to other battalions in the Brigade Combat Team (BCT). Frequently, units will report that their HF is 'up' or 'green,' however, in most cases JRTC OC/T's observe that this really means the unit sets up and turns on the HF radio, but they have not made communications checks to any other station.

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What OC/T's commonly observe are two methods of employment. In the first method, they see the reconnaissance squads in the dismounted cavalry troop (C Troop), use HF in predetermined communications windows to report to their troop headquarters. In most cases, these communications do not enable timely or accurate reporting unless the unit is fortunate enough to observe the enemy near-simultaneously with their communications window. In the second method, a troop headquarters will establish HF communications with the Squadron as an alternate or as a contingency in the PACE (Primary, Alternate, Contingency, Emergency) Plan rendering it as an infrequently used or unused method of communications.

Common to both methods is point-to-point calling where two stations communicate solely with each other. This communication does not enable a rapidly shared understanding across the Squadron and therefore, does not serve as a suitable alternate option in a unit's PACE plan for a designated net. HF, however, supports the ability for all stations to hear the traffic and requires additional training for units to understand how to conduct a point-to-multipoint, or "ALL," call through Automatic Link Establishment (ALE).

Why units struggle with HF in a DATE Scenario

Units struggle to use HF in a DATE scenario because they lack the requisite level of training in antenna-theory and frequency selection to build an HF network sufficient to enable Mission Command. Operator training in these areas atrophied as units focused on bandwidth-intensive mission command systems and VHF/UHF line-of-sight (LOS) tactical radios. Five contributing factors below elaborate on why units struggle to make HF work.

HF Frequencies. In HF communications, the frequencies between 2 and 30 MHz all behave differently from frequencies in the VHF and UHF bands.

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Spectrum managers often provide a unit with twenty different HF frequencies and consider this amount more than sufficient. Over seventy-five percent of these frequencies could be unusable because they do not fall within the range of 2 MHz to 10 MHz that enable HF Near-Vertical-Incidence-Skywave (NVIS) communications. One can visualize NVIS communications as water exiting a hose pointing straight up and splashing back down equally in all directions. This allows units to communicate near or out to 400 miles and can even enable units to communicate over large obstacles like tall buildings found in urban environments or over mountains. The usable frequencies within this NVIS range change between day and night because of the changes in the layers of the ionosphere that allow for it to refract signals back to earth. To support frequency selection, planners use a program called Voice of America Coverage Analysis Program (VOACAP) to provide a near-accurate report of which frequencies will support an area of operation for a specific duration of the day. Equipped with this analysis, units can make sure that spectrum managers are issuing frequencies that will support the mission.

HF Antennas. Units require different antennas to achieve different distances, depending on who a unit needs to contact. HF NVIS propagation can continuously support an entire area of operation out to roughly 400 miles. Units achieve this through VOACAP analysis frequency selection and through the correct selection of antennas to achieve high-angle take-off radiation. Bending an HF vertical whip antenna forward or backward for mobile operations or setting up a simple dipole antenna at least one-quarter wavelength above the ground for at-the-halt operation will achieve this high-angle take-off. Previous experience has shown that the NVIS AS-2259 antenna system, with its difficulty in tuning and easily lost parts, is not as effective as a dipole antenna. Units need not

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worry about which azimuth a horizontal dipole antenna is facing as these antennas radiate omnidirectional when placed in NVIS operation. This helps reduce setup complexity of the dipole. The azimuth of the dipole antenna will have a more significant impact when achieving much longer distance contacts such as 1000 or 2000+ miles away.

ALE "Individual" versus "ALL" Call. Given units want shared understanding; it is important that all stations on the net receive information at the same time. Automatic Link Establishment (ALE) is a technology that allows up to thirty-two individual stations to take part in a single ALE net that will automatically link stations together on the best frequency for that time of day from a pre-stored list of frequencies. ALE can link individual stations together or allow a station with traffic to connect to all stations through an "ALL" call. ALE has an added benefit of also allowing stations to transmit short text messages to each other. Units that do not understand how ALE works cannot use this technology built into every HF radio. It takes the guesswork out of knowing which frequency to switch to during the day or night and supports sending quick text messages.

Insufficient Training in Building an HF Network. The signal plan in the scheme of Mission Command should aim to achieve a shared understanding. In HF communications, units should avoid point-to-point "Individual" calling, and build an HF Network set to broadcast "ALL Call" to multiple receivers from a single station. While training an HF radio operator on how to place a call is relatively easy, ***building and maintaining*** an HF network in a DATE scenario is difficult. Building an HF network requires knowledge amongst operators across the formation on how to create an HF plan and programming that plan into the radio, understand HF wave theory, and propagation, VOACAP, and antenna theory and employment.

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Across all Cavalry Squadrons, JRTC OC/T's do not observe the required number of operators are not sufficiently trained to program the HF radios correctly, and adjust the plan, type of antenna, and antenna polarization daily as units move in a DATE Scenario to maintain an HF network that can enhance shared understanding. The U.S. Army Reconnaissance Center at Fort Benning, Georgia does a great job of training the usage of HF in reconnaissance missions. We strongly encourage units to send select Cavalry troopers to this school to bring back this HF knowledge and then to consistently use HF communications within their unit.

Battery Consumption for Dismounted Scouts. PRC-150s require two BA5590s at a time, double the battery requirement of a RT-1523 FM LOS radio. Unless a unit can get a sustained resupply of BA5590 batteries, it forces HF operators in dismounted reconnaissance squads on or near the forward line of troops to only use the HF radio during pre-determined communication windows to conserve battery life. Communication windows last twenty minutes every four to six hours. When units can communicate only during these communication windows, they are deficient in adhering to the Fundamentals of Reconnaissance to "report information rapidly and accurately." This limitation discourages units from using HF in their PACE Plan. These dismounted reconnaissance squads will need to consider solar-powered based rechargeable systems and extra rechargeable batteries in combination with using the lowest output power setting required to maintain contact to expand their communications windows.

Resources available to units

Foremost, units should read U.S. Army Doctrine that includes the Field Manual, Army Techniques Publications, Training Manual, Technical Bulletins, and Training Circulars that cover HF radio operation.

These include FM 3-55.93 *Long-Range Surveillance Unit Operations* Chapter 6: Communications [June 2009], FM 6-02 *Signal Support to Operations* [January 2014], ATP 6-02.53 *Techniques for Tactical Radio Operations* [January 2016], ATP 6-02.70 *Techniques for Spectrum Management Operations* [December 2015], ATP 6-02.72 *Multi-Service Tactics, Techniques, and Procedures for Tactical Radios* [May 2017], TM 11-5820-1501-13&P *Operator and Field Maintenance/Repair Parts for AN/PRC-150A*(C) [May 2013], TB 11-5820-1141-10 *Operator Manual for NVIS Antenna Handbook* [June 2008], TB 11-5820-1148-10 *Operator's Antenna Erection and Recovery Guide for HF Antenna System* [December 2005], and TC 9-64 *Communications-Electronics Fundamentals: Wave Propagation, Transmission Lines, and Antennas* [July 2004].

The most important of these publications for Cavalry Squadron leadership and radio operators to know and understand is Chapter 6 of FM 3-55.93 and TC 9-64. Although there is the ATP 3-20.96 *Cavalry Squadron* [May 2016], ATP 3-20.97 *Cavalry Troop* [September 2016], and ATP 3-20.98 *Reconnaissance Platoon* [April 2013], these only briefly mention HF as a means to communicate. Leaders and radio operators can access these publications at https://armypubs.army.mil.

In addition to the doctrine, there are also many published articles on military HF employment. LTC (Ret.) David Fiedler and LTC (Ret.) Edward Farmer are the Army's most prolific authors on military HF usage publications. Their articles in the *U.S. Army Signal Corps Army Communicator* include the following: *Beyond-Line-of-Site Communications* (Fall 1983), *Skip the "Skip Zone": We Created It and We Can Eliminate It* (Spring 1986), *Russians on the Move – Near-Vertical-Incidence-Skywave* (NVIS) (Winter/Spring 1987), *On the Move - Mobile NVIS: The New Jersey Army* (Fall 1987), *Making it Work – Automated HF Communications For Nap-of-the-Earth Flying* (Spring 1994), *Planning for the Use of High-Frequency Radios in the Brigade Combat Teams and other Transformational Army Organizations* (Fall 2002), and AN/PRC-150 *HF Radio in Urban Combat, Mobility Favors Small Antennas*, and *HF Combat Net Radio Lesson Learned Again* (2004 Vol. 28 No. 4). The last three articles listed from the 2004 Vol. 28 No. 4 edition of the *Army Communicator* are the 'must read' for any tactical commander and his or her unit. Units can access the *U.S. Army Signal Corps Army Communicator* magazine online at the following address: https://signal.army.mil/index.php/resources/public-resources/army-communicator/267-archives. Once there, units can search for magazine editions to find the articles listed above.

The U.S. Army Network Enterprise Technology Command (NETCOM) maintains the Army Military Auxiliary Radio System (MARS) program headquartered at Fort Huachuca, AZ. This global system is comprised of multiple HF Gateway stations and numerous volunteer members with units that may contact to test their equipment and ensure they can make radio contact at short or long distances. Units may contact them at (520) 533-7072 to arrange a test HF radio contact.

Units can use the training documents and videos found on the LandWarNet eUniversity website https://lwn.army.mil and through the S6 Community of Purpose (https://nec.army.mil/portal/index.php/s6-cop-home). When users browse to the S6 CoP High-Frequency folder in the Documents repository, they will access numerous articles from Cavalry leaders such as MAJ Michael Hefti's paper titled, "The Need for Proficient Use of High-Frequency (HF) Communication within Cavalry Organizations," and training slideshows.

We also encourage units with authorized personnel to establish a Harris Tactical Communications Premier account at https://tcpremier.harris.com to access the latest software, drivers, and firmware for their HF radios and contact Harris for technical and training support. Having the latest software, drivers, and firmware is essential in achieving successful HF operation. Radio operators use computers to load the frequency and net plans into every radio. Units must ensure they have computers loaded with the software and drivers necessary to perform this function. Units can also leverage Communications-Electronics Command (CECOM) Logistics Assistance Representatives (LARs) to provide on-site support in training and assistance in ordering the correct component of end items (COEI) and basic issue items (BII) necessary to set up HF radios in vehicles and tactical operation centers. To test the HF skills of units, NETCOM hosts a low-powered HF radio competition called QRPX held at the end of every March. The Canadian Armed Forces host the Noble Skywave HF radio competition every October to test HF skills and multinational interoperability amongst NATO and partner countries.

Finally, we encourage Soldiers who want to further hone their HF skills to study for and earn their Amateur Radio license. This license is a clear way to show tested and certified knowledge in radio communications. Soldiers can then practice and hone their HF radio skills in their free time in a non-military setting. Units can find that local amateur radio clubs offer license exam classes and exams by searching this site http://www.arrl.org/find-an-amateur-radio-license-class.

RECOMMENDATIONS AND CONCLUSION

This article explains the Army's struggles with the tactical employment of HF communications in a DATE scenario through the lens of the IBCT Cavalry Squadron. The difficulties result from a lack of sufficient command guidance in ensuring regular training, maintenance, and usage of HF. The difficulties also stem from poor spectrum management in which units receive frequencies that do not support the propagation conditions. The fact of the matter is CTC's are now requiring the use of HF radio to prepare for Large-Scale Combat Operations in which units will almost assuredly face a cyber-contested environment in which the enemy will direction find and jam their VHF/UHF tactical radio communications. Units have the basic MTOE to support communications between all key leaders throughout all echelons. Unit commanders need to ensure that their MTOE has all the serviceable COEI and BII required for either base station, vehicular, or dismounted variants of their HF radios.

Units need to ensure they are using all available resources to conduct training on HF, so they know how to select the correct antennas and use the right frequencies to make HF communications work. Spectrum managers, just as operators do, need to better their understanding of how HF radio communications work to ensure they are issuing frequencies that will support the mission both during the day and at night. The primary advantages HF provides units in a DATE scenario are enabling Beyond-Line-Of-Sight (BLOS) communications and the ability to operate in a cyber-contested environment due to the inherent difficulties in direction finding HF communications. Commanders need to think about Mission Command in terms of the minimum essential traffic required to disseminate mission orders and attain a shared understanding to achieve decisive action through disciplined initiative.