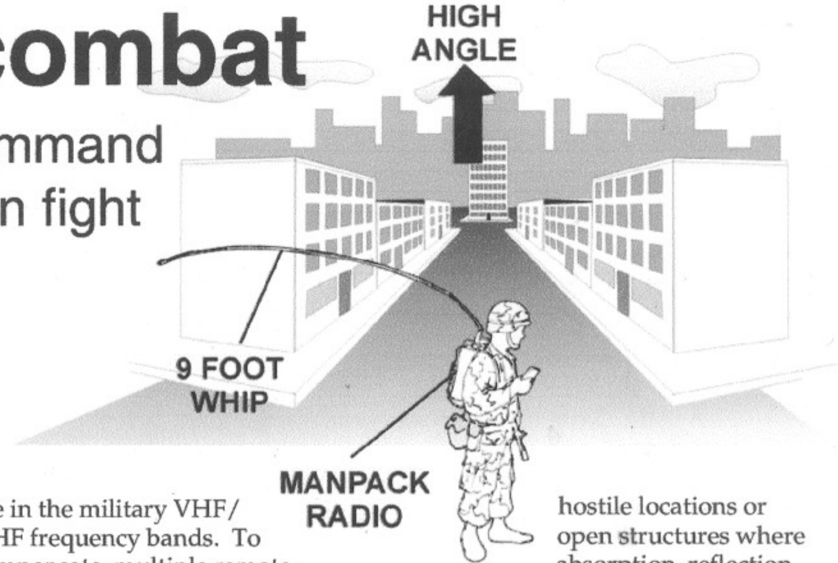
AN/PRC-150 HF radio in urban combat

– a better way to command and control the urban fight



by retired LTC David M. Fiedler and LTC Edward Farmer

Communications in the urban environment

Using Army standard-tactical-radio communications systems on urban and complex terrain has never been very easy. Inherent equipment limitations found in military radios (low power levels and inefficient antennas) coupled with system degrading effects inherent in the urban setting such as signal absorption, scattering and diffraction present many challenges for the combat-net radio user operating with the current suite of military frequencies (2-512 MHz).

Civilian police, fire and municipal service agencies have faced these same challenges for many years. The classical answer has been to position retransmission stations (repeaters) at strategic locations on the urban area of operations. By placing repeaters intelligently (usually atop high structures) and by selecting power levels and antennas with good coverage patterns city governments have long been able communicate among base-station, hand-held and vehicular radios pretty well. As far back as the 1930s the radio frequencies employed by civil government were in the same general very-high frequency/ultra-high frequency range used by many of today's military radios. Recently, in order to relieve frequency congestion and bandwidth availability problems, many urban centers have migrated to much higher frequency ranges where scattering, reflection and absorption are worse than they are in the military VHF/UHF frequency bands. To compensate, multiple remote repeaters connected to transmission hubs are used to improve coverage over wide areas or into hard-to-cover spots. Network repeaters are connected to command stations (trunked) over telephone cable, fiber-optic cable or microwave carriers and typically assure maximum reliability, area coverage and user access to the civil networks.

Modern cell-phone networks now also operate in this same general frequency range. Each "cell" access point (antenna tower) is positioned for direct (radio line-of-sight) connectivity to subscriber-cell phones located in their coverage area. The access points are interlinked with additional infrastructure including switches and tie lines.

These systems work well in the civil-urban environment because the system designers have the luxury of controlling the infrastructure and major-system parameters such as power levels, antenna locations, number of access points and repeaters. If a "dead spot" is discovered it is usually a simple matter to engineer and interconnect additional repeaters or cells to eliminate it. In addition, most civil-radio and cell-phone communications are directed to subscribers in relatively open non-hostile locations or open structures where absorption, reflection and other signal-propagation losses are a factor that can be dealt with. When operation becomes marginal users can simply step outside or move closer to a building window etc. and operations will normally improve as a result of improved line-of-sight signals to the repeater or cell access point.

It's different with the Army...

When the Army is engaged in urban-combat operations the communications situation is considerably different from the situation faced by civil government or cell phone users. Military difference factors include:

1) operation restricted to the frequency range of common military radios (2-512Mhz),

2) limits on the output power of military radio equipment,

3) limited number of available repeater assets if any,

4) limited access to good repeater locations due to enemy action,

5) need to communicate to both outside street locations and inside structures,

6) lack of standard compact antenna systems useful for urban combat,

7) severe restrictions on the

movements of system users,

8) lack of manpower required to cover multiple signal sites can easily exceed available resources. And more.

... but there are ways ...

Fortunately, there are new equipment and techniques available in the force that can, if intelligently applied, overcome many of the communications limitations created by urban combat. One of these is the use of the lower portion of the HF radio spectrum.

Near Vertical Incidence Sky-wave

For many years the Army has known that radio signals in the lower portion of the HF frequency spectrum (2-8Mhz) when radiated at near-vertical angles shower down off the earth's ionosphere (a atmospheric layer of electrically-charged gases at an altitude of approximately 200 miles) in an omni-directional gap-free energy pattern with a radius of hundreds of miles. This transmission technique is called Near Vertical Incident Sky-wave because the signal energy is launched mostly on high (toward the sky) angles between 45 degrees and the zenith and returns to earth after ionospheric reflection. The returning signal comes down from above at high angles in an omni-directional pattern that has no gaps and a radius of hundreds of miles.

While in the past the Army was primarily interested in NVIS for covering theater/corps size areas of operations NVIS is also very useful on the urban battlefield. The advantage of NVIS signals for urban combat is simply that most of the radio energy after ionospheric refraction is not bent, blocked or absorbed by the urban environment in the way that surface wave (low angle) signals from vertical antennas would be. NVIS signal losses are limited to only free space path loss and some absorbs ion at the ionosphere reflection point. Because of this, a Soldier with the Army's new AN/PRC-150 HF man-pack radio (see *Army Communicator* Winter 2001) and the correct (horizontal) antenna (see *Army Communicator* Fall 2002) can easily receive these high-angle signals if located in open areas between urban structures such as streets, parks, roof tops and other open urban places. The communications path is from the transmitting antenna to the ionosphere and on to the receive antenna. Transmission losses remain fairly constant at around –120 db (a number that can be overcome easily with our equipment) over the entire area covered by the signal. The NVIS signal pattern is truly omni-directional even at very short distances and this makes the transmission mode useful for urban fighting as well as wide area and long distance communications.

HF and structures

Because of their longer wavelengths (lower frequency) HF (2-30Mhz) signals will naturally penetrate urban structures more deeply than signals on higher, shorter wavelength frequencies. How deep the penetration depends on exact frequency, signal power level, antenna efficiency and the makeup of the urban structures in the path.

The name of the game in all radio communications and particularly urban combat radio communications is overcoming path loss. Simply put, the greater the radiated signal and the lower the frequency the more path loss can be overcome. This raises the probability of successful communications in urban areas and inside buildings. Stated mathematically, and greatly simplified:

$$Path\ Loss\ (PL) = 20\log\left(\frac{4\pi d}{\lambda}\right) + K_\lambda$$

π is the well-known constant, d is the distance between transmitter and receiver, l is the wavelength at the operational frequency, and Kl is a power loss constant determined by characteristics of the obstructions in the signal path at the wavelength of the operational frequency. For grounded solid-metal buildings without windows etc. K is a very large, meaning that path losses cannot be overcome in order to communicate. For wood and tarpaper structures still found in many urban environments K becomes very small so the first term in the equation predominates. Brick and concrete structures increase K but not to a level where communications fail more often than not. Most structures are inherently (and surprisingly) fairly radio-transparent at HF frequencies. As an example of HF signal penetration it is not uncommon for a small ground penetrating radar transmitter operating in the HF frequency range to penetrate over 100 feet into common kinds of earth while the same power radar on a higher frequency will penetrate much less.

What does this equation mean in practical tactical communications terms? It means, for example, that if we are using a common VHF military radio operating at 30Mhz (lowest frequency for single-channeled ground-to-air radio systems etc.) and replace it with an HF radio like the AN/PRC-150 operating, at say, 5Mhz the path loss drops by 20 decibels (db) because of the way that longer wavelength (lower frequency) signals propagate. In this case lowering the frequency is the equivalent to increasing the power of the transmitter by a factor of almost seven.

Another important consideration for urban combat is raw power. Obviously, the more power you have the more path loss you can overcome and the deeper your signals will penetrate into structures. Common tactical VHF man-pack radios like SINCGARS have a maximum output power of four watts. The AN/PRC-150 HF radio has a maximum output power of 20 watts. That is 7db* more signal power to overcome losses caused by the path, path obstructions, inefficient antennas and other signal consuming factors. Yes the extra power will help you but power relationships are tricky, look at the table below:

4 watts	= 36 dbm*
20 watts	= 43 dbm*
50 watts	= 47 dbm*
150 watts	= 52 dbm*
400 watts	= 56 dbm*

dbm* = decibels above a miliwatt. The db* is a logarithmic unit used to describe a ratio. The ratio may be power, or voltage or intensity or several other factors but in this case it is power (watts). If you do the math you will see that you can measure the difference of two power levels by taking 10 log of their power ratio. If the ratio of power is, for example, two, meaning one radio transmitter is double the power of the other then the difference is 3db. Put another way, for every 3db gained by making a more efficient antenna system or cutting transmission line loss etc., is the equivalent to doubling the transmitter power.

The point here is that often, adjustments to antenna systems or operational frequencies to make an antenna more efficient can produce far more dbs of signal power than simply increasing the raw transmitter power. More power will always help overcome path loss for both NVIS and ground wave systems but many times it is not the best or only answer. If you are already operating at the maximum power that the transmitter can produce then these adjustments do become the only way to compensate for path loss and improve signal penetration in the urban combat environment.

Think "system"

Communications between two radio stations requires that the transmitter power – transmitter antenna gain – receiver antenna gain – receiver performance overcome the path loss between stations. A low-power outstation radio such as a man-pack radio with an inefficient antenna used by forward troops can be "compensated for" to a degree when communicating with a base station that is typically using a higher performance receiver and a more efficient antenna. When the path is reversed, the typically higher-power base-station transmitter and the more efficient antenna again compensates for lower performing combat unit radios in the net. Communications between low-power outstations is much more difficult and may even require retransmission (relay) through a more efficient base station.

In the urban fight, man-pack small unit HF radios, such as the new AN/PRC-150 are extremely portable, but are antenna and power challenged. A high degree of portable NVIS (sky-wave) effect can be obtained when needed by simply physically reorienting standard vertical man-pack or vehicle (whip) antennas to the horizontal plane (see Fig. 2). Direct (surface wave) signals are simpler to generate and use inside structures are also produced from the same antenna by just leaving the antenna vertical.

Communication between two stations by either NVIS (sky-wave) or surface wave transmission only requires that the path loss between them be overcome by the radios and equipment at the ends. Surface wave connectivity while simple to produce is often more difficult to achieve when there are signal robbing surface path obstructions. Surface obstructions can be eliminated under some conditions if the path chosen is sky-wave (NVIS). Do not however rule out the use of surface wave (low angle) signals as a transmission mode in urban combat.

A large station such as a fixed or mobile tactical operations center has the opportunity to erect more efficient antennas and operate more powerful radio equipment thus compensating for some of the system limitations encountered when trying to communicate with typical low powered radios (usually man-packs) carried by combat troops. Highly efficient, large, horizontal-wire antennas are fine for fixed or at the halt, company and higher command-post locations. CPs, have more freedom to select good communications sites even on the urban battlefield. Base-station equipment can make up for much of the system losses caused by having to use low power man-pack radios with inefficient antennas at the fighting locations. The decision to use high-angle or low-angle transmission mode is the call of the combat unit Signal officer. This decision must be made based upon and a knowledge of antennas and radio propagation.

Generally, if the fighting is in the streets and from rooftop to rooftop, C2 elements can standoff from the battle area and control the fight using high-angle (NVIS) communications. If the fighting is inside structures and masked from high-angle signals the C2 element may need to get in close and pump

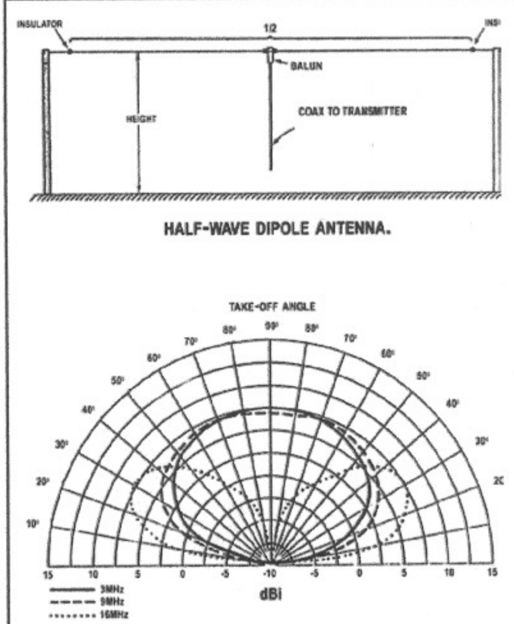


Fig. 1 Horizontal dipole antenna pattern 8 meters above ground. Note that at the lower (NVIS) frequencies, the bulk of the radiated energy is on angles between 40 and 90 degrees.

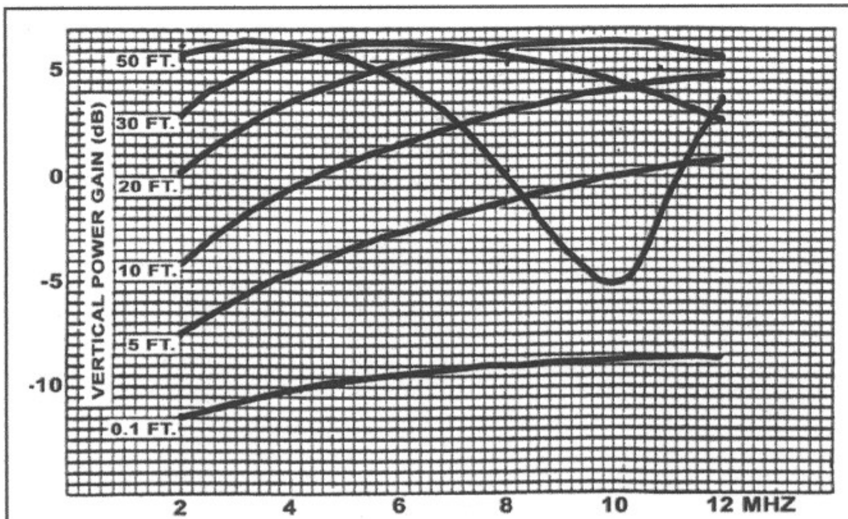


Fig. 1a Vertical power gain at various heights across the NVIS frequency band.

signal energy directly at structures being attacked using vertical (low angle) whip antennas.

A C2 HF base station

High-angle NVIS signals can be easily generated from simple horizontal wire dipole antennas located close to the earth (see Fig.1). The best performance at NVIS frequencies occurs when the antenna is about ¼ wavelength (about 30 feet at 8 mHz) above real ground. The desired gap-free omni-directional antenna pattern shape remains constant, but with markedly reduced signal strength, even when the antenna is lowered to ground level (see Fig. 1a).

A good base-station antenna is critical because it helps the path loss in both directions however, when the tactical situation is such that it is not possible to erect an antenna at the ideal height a lower height will not shut the circuit down. This is true of length also. Perhaps the ideal antenna for a tactical CP base station is the inverted "L" (see Fig. 3a and 3b).

This antenna is efficient if it has the correct dimensions and produces both high angle horizontal polarization for NVIS communications and vertical polarization for compatibility with man-pack and vehicular vertical antennas using low angle (ground-wave) signals at the same time (see *Army Communicator* Fall 02 for discussion on polarization). It is important to note that mixing polarization in Line of Sight ground-wave nets (cross polarization) will cause a huge (20db+) amount of signal loss. Inverted "L" antennas avoid this problem simply because they provide efficient signals with both polarizations in case someone doesn't get the word. Comparing Fig. 1 (dipole) and Fig. 3 (inverted "L") shows the magnitude of the signal difference in the vertical (NVIS) direction when compared to a standard horizontal dipole (Fig. 1).

This loss that is small and is the price paid for generating both high and low angle signals from the same antenna. Inverted "Ls" do need some room to be operated at peak efficiency. Ideal lengths for 35 foot vertical elements are shown below:

frequency range (MHz)	horizontal length (feet)
2.5 – 4.0	150
3.5 – 6.0	100
5.0 – 7.0	80

shorter lengths to match tactical situations will also work but antenna efficiency again will be somewhat reduced.

Portable antennas

The AN/PRC-150 is normally equipped with the OE-505 10-foot vertical monopole whip antenna. Even at ten feet, this is a very "electrically short and inefficient" antenna (an ideal quarter-wave whip at 5 MHz would be 47-feet long). It is normally operated using only the radio loosely coupled to surrounding earth as its counterpoise (radio frequency ground system needed to complete the antenna circuit). This is a very inefficient arrangement compared to what we easily achieve at base stations through the use of balanced antennas (dipoles) or ground radial systems for vertical antennas.

When the fight enters buildings even the ten-foot whip becomes impossible to use. With the full realization that a still shorter antenna will have even lower efficiency than the OE-505 we are left with the requirement to find one. Fortunately, the AN/PRC-150 includes an excellent antenna tuner capable of electrically matching the radio impedance to extremely short antennas, so choices are available.

Physically shortening an OE-505 is an obvious approach, but there's an even better answer that does not destroy the OE-505. The AS-3683 3 foot metal tape antenna that comes with the AN/PRC-119 SINCGARS radio (the most common radio in the Army) will fill this bill perfectly (see Fig. 7). In addition to having a less than 3-foot long radiating element that is short enough to take into a building and stay vertical (the predominant orientation for troops moving inside buildings), the antenna base is a flexible "goose neck" that can be easily bent horizontal for man-pack NVIS operation when the situation permits.

There are some other things we can do to improve the performance both of these admittedly short and inefficient antennas. Operators need to remember that man-pack anten-

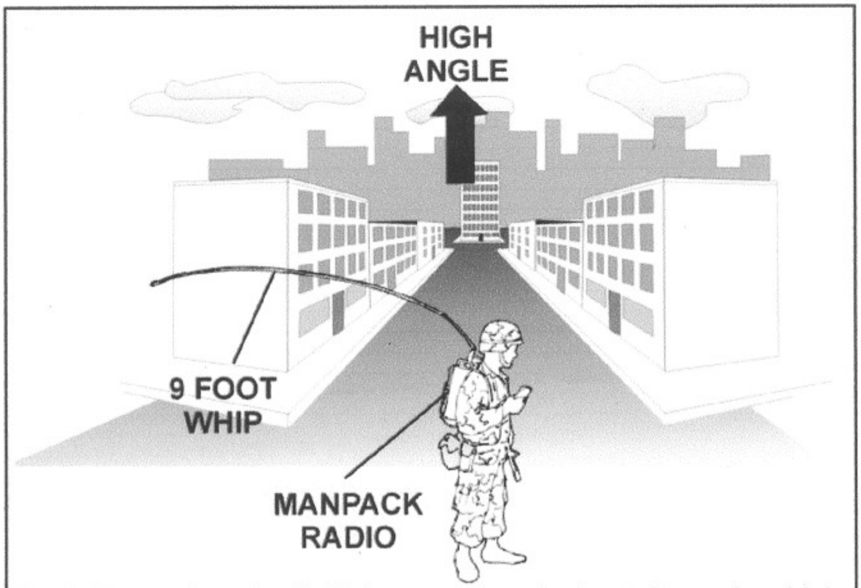


Fig. 2 Man-pack vertical (whip) antenna bent horizontal toproduce high angle (NVIS) horizontal dipole like antenna pattern.

nas really consist of the whip (radiating monopole) and what ever is under the whip. All antennas have two sides, and when used in the standard way, the man-pack antennas other side (called the ground plane or counterpoise) really consists of the radio chassis, the operator's body, and whatever the soldier is standing near at the time the radio is operating. Improving the counterpoise/groundplane can provide a tremendous improvement in radiated power and received signal level at almost no cost.

A much better counterpoise in the urban situation is simply a "tail" (see Fig. 6) connected to the radio's ground terminal and hung behind the operator. The longer the tail is the better. Making it about the equal length as the AS-3683 (1 meter) works well in terms of both electrical performance and practicality. Any conductor will do, but the more surface area the better, and copper works better than materials with higher resistive characteristics. The best "tail" construction that we have found is a simple section of computer ribbon cable shorted on both ends with one end terminated on the equipment (chassis) ground. This "tail" can dramatically increase the effective radiated power from the antenna. When possible, removing the radio from the operator's back will also improve the signal strength since the body will no longer serve as a signal robbing capacitive path to ground. While on the ground, a ground rod and at least four wire radials spread out and connected to the radio ground can produce even greater signal power.

Can it ever get better than this?

This looks great but don't rush off just yet to replace the VHF radio in your squad with an HF man-pack radio. Why? The antenna again! See Fig. 5. The path loss equation above only describes what happens once a signal has been radiated – not how the signal gets generated. You must remember, to radiate at top efficiency a monopole (whip) antenna should be physically ¼ wavelength (λ) long, and it also needs an extensive low impedance counterpoise. At HF frequencies that is physically a very large antenna. All small antennas suffer inefficiencies.

As an example of how efficiency is reduced as the antenna gets shorter and antenna impedance is mismatched to the radio, look at Fig. 5. Fortunately, modern HF equipment such as the AN/PRC-150 are equipped with a very effective antenna matching unit that is quite capable of providing acceptable antenna electrical impedance matching even to very short antennas. Unfortunately, while the coupling process electrically compensates for a physically short antenna it also reduces effective radiated power of the radio as shown.

The AN/PRC-150 has some additional tricks to help make up for this…

In addition to the higher power levels and better physical

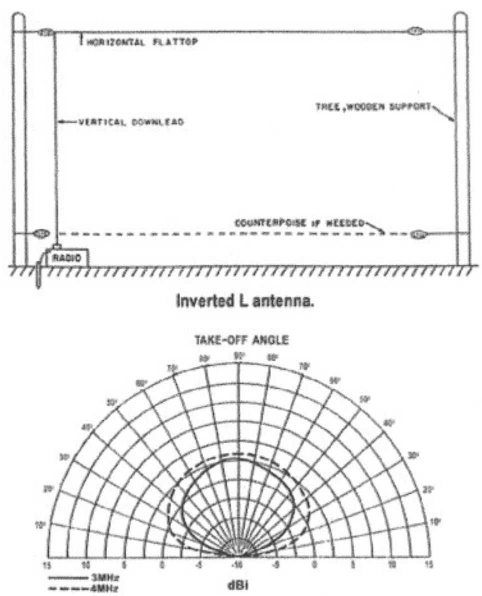
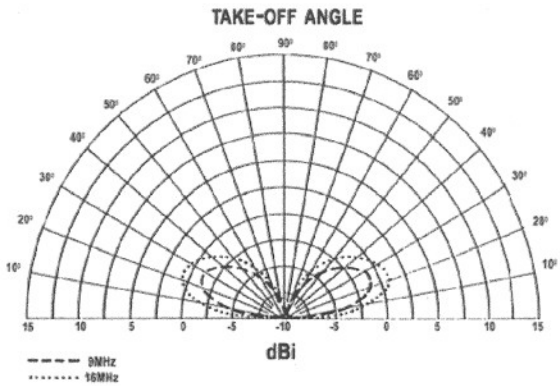


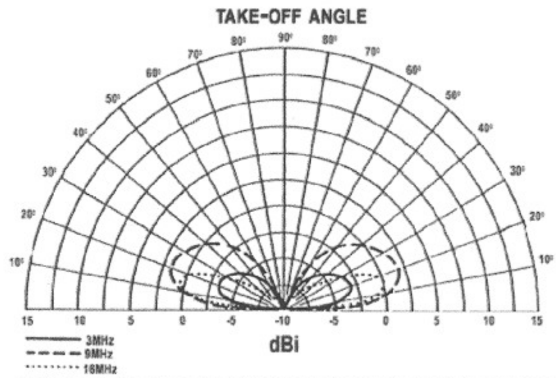
Fig. 3a Typical inverted "L" horizontal antenna pattern generated by the horizontal part of the "L" note high andgle (NVIS) energy pattern.

signal penetration capabilities of HF radio the AN/PRC-150 has other ways to make back signal lost in the path and the inefficient antenna. The U.S. government (NSA) along with private industry has developed and adopted a new form of digital voice modulation coding called Mixed Excitation Linear Prediction.

MELP implemented in the AN/PRC-150 can operate at both 600 and 2400 bps data rates. MELP has demonstrated an ability to provide a significant increase in secure voice availability over degraded channels particularly at the 600bps data rate when compared to other digital and analog forms of voice modulation. The MELP speech mode uses an integrated noise pre-processor that reduces the effect of background noise and compensates for poor response at the lower speech frequencies. By using digital voice techniques such as band-pass filtering, pulse-dispersion filters, adaptive-spectral enhancement and adaptive noise pre-processing voice communications performance over channels with low signal-to-noise ratios typical of the urban combat environment can now be made useable and reliable.



Fifteen-foot vertical whip antenna pattern.



Thirty-two-foot vertical whip antenna pattern.

Fig. 3b Typical inverted "L" vertical antenna pattern generated by the vertical part of the "L" note low angle (groundwave) energy pattern.

The MELP capability just like lowering the frequency, using higher power, and improving antenna efficiency translates into dbs of "processing gain" and a better capability to communicate over urban terrain. In effect MELP is compensating for path loss and antenna inefficiency.

The signal-to-noise channel characteristics needed to support various modulation modes are shown in Fig. 8. Note that MELP 600(bps) digital voice performs almost as well as a CW (manual Morse Code) expert operator. Quite an achievement since until recently all services tried without success to keep a pool of trained CW operators available because CW Morse Code could get through under conditions that would support no other means of communication. A good look at Fig. 8 also shows this. Analog voice communications is achieved at a S/N ratio of about 12-to-1. Good MELP 600 digital voice communications is achieved at about a ratio of 3-to-1. The ratio of the two modes means a 4-to-1 improvement in communications by going to MELP 600. From the signal power prospective, this is an increase of 6 db (equal to four times the transmitter power) due to gain from digital signal processing. Viewed another way signal gains of this magnitude effectively make a 20 watt radio into the equivalent of an 80 watt radio at the push of a software button but without causing increased stress on radio components that would normally require higher (more expensive) power ratings, and decreased operational life of the radio batteries.

Also shown in Fig. 8 is a digital voice mode identified as Last Ditch Voice. This mode as the name implies is designed to work when nothing else even a manual Morse CW expert will. LDV takes advantage of digital voice processing at a much lower data rate (75bps) in order to slash digital errors caused by marginal conditions. LDV is not a "real time" transmission mode but LDV has both a broadcast and an automatic-request-for-retransmission capability. Voice data packets are created and sent in the transmitting radio. The radio then sends the packets at a very slow data rate using sophisticated error detection and correction digital coding techniques. Data packets are stored in the receiving radio and checked for errors in transmission caused by poor transmission path characteristics. In ARQ mode an automatic request to retransmit corrupted packets can be returned to the transmitting radio in the event to many packets have too many errors for decoding into useable voice communications. In broadcast mode all packets are stored upon receipt the first time. Radio software then assembles the packets and cues the operator. The soldier at the receiving radio then plays the message like a voicemail. The lower data rate and extensive signal processing can produce impressive performance since LDV can recover signals from below the noise levels (see Fig. 8). This again can be equated a considerable increase (perhaps 3db or double) in transmitter power.

To summarize, S-6s and G-6s should consider the following points that make the Army's new family of HF radio a better way to communicate than other means for urban combat if:

1 – Lower signal loss and better penetration into buildings due to propagation characteristics of lower operating frequency.

2 – Higher raw transmitter power to make up for signal losses in the path and due to inefficient antennas.

3 – Lower signal loss through heavy foliage, rain and snow because of longer wavelength.

4 – Lower transmission line losses.

5 – Eliminates need for hard to place and tactically dangerous repeater stations.

6 – Less effected by complex terrain.

7 – Better performance (effective power gain) due to MELP 600 DSP.

8 – Last Ditch Voice digital mode for recovery of extremely weak signals.

9 – Ability to use both sky-wave and surface-wave paths depending on the tactical situation.

Make no mistake; tactical communications under urban combat/complex terrain conditions is sometimes a very hard thing to do. G6 and S6 officers will need to know how to pick an antenna, mode of transmission, and frequency band that will provide the key to success. Much depends upon the skill of unit Signal officers. Using our new HF equipment can help get the message through. Communications planners at every level need to understand the concepts of propagation, path loss, antennas, antenna couplers and digital signal processing as outlined. When they do the chances of getting critical C2 information to all echelons of an urban combat force via HF-CNR will be much better.

Note: At this time, the number of HF radios in the force is not overwhelming. There will be situations where there just is no AN/PRC-150 or other HF man-pack radios around to use in the urban fight. In this case we will have to fall back on existing stocks of VHF/UHF radios like SINCGARS or AN/PRC-126, or the new commercial-off-the-shelf CNRs that are now appearing in significant numbers such as the AN/PRC-117F (man-pack/vehicular) and the AN/PRC-148 (handheld). The principals outlined above such as using the lowest frequency at VHF and improving antenna efficiency all still apply. Measures such as

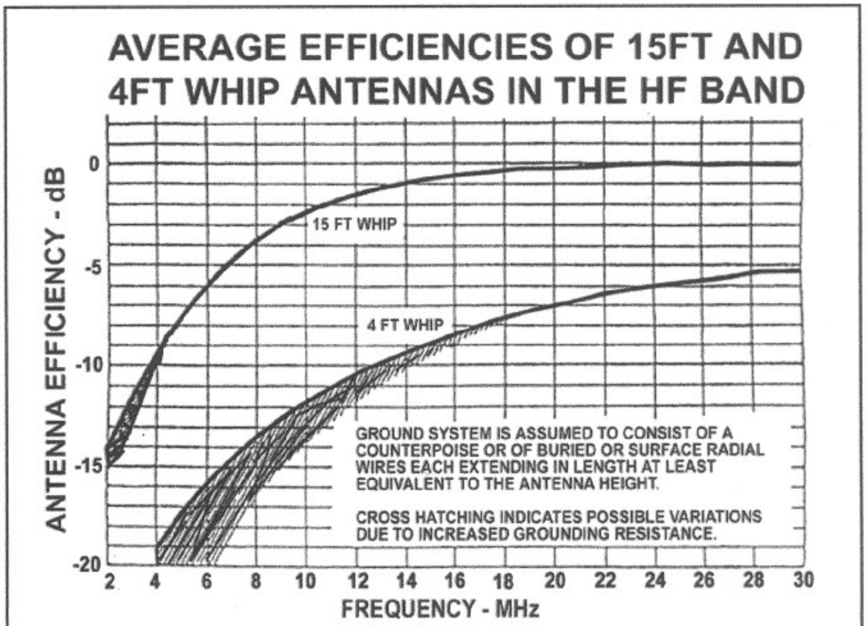


Fig. 5 Effect of shortening vertical HF antennas from 15 feet to 4 feet for convenient operation when in urban combat (6-9db). Shorter antennas will give even greater antenna losses. In addition, most radios will automatically cut output power as the antenna gets shorter.

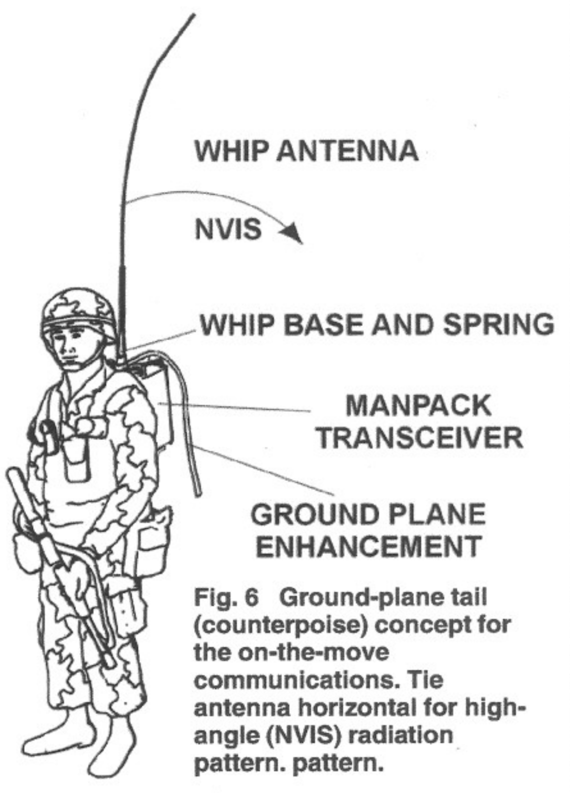


Fig. 6 Ground-plane tail (counterpoise) concept for the on-the-move communications. Tie antenna horizontal for high-angle (NVIS) radiation pattern. pattern.

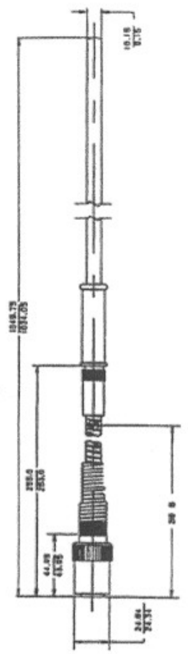


Fig. 7 AS-3683 SINCGARS metal tape Manpack Antenna with flexible gooseneck base that can be made vertical for ground-wave HF communications or horizontal for sky-wave (NVIS) communications. AN/PRC-150 antenna tuner/couplers will impedance match this antenna but efficiency will be poor. Antenna suitable for vertical use inside buildings. Use longer OE-505 if possible. Try higher (shorter wavelength) HF frequencies if possible for better efficiency.

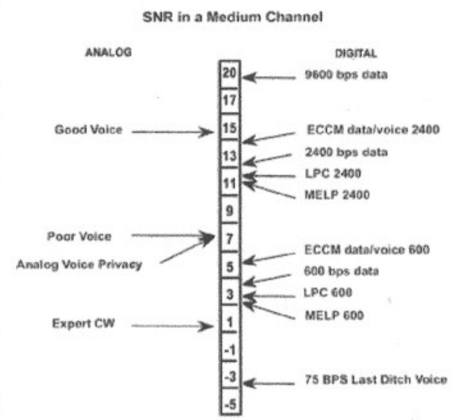


Fig. 8 Signal-to-Noise Ratios required for different AN/PRC-150 transmission modes. Note LDV recovers signals from below the noise level and MELP 600 operates well in a low S/N ration weal signal environment commonly found in urban combat environments.

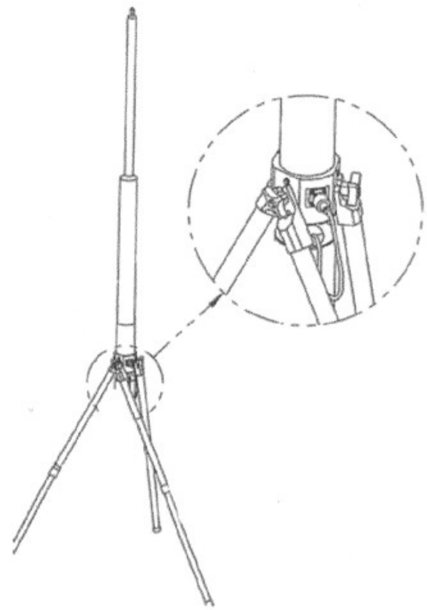


Fig. 9 COM-201 VHF (30-88Mhz) self-supporting ground-plane antenna. COM-201 can easily be brought forward for urban combat since it has a small self-contained package and requires no mast. Good low angle radiation and gain characteristics are a great help under urban combat conditions.

providing antenna tails etc. will also help these radios to increase signal levels just like they will an HF radio and for the same reasons. NVIS of course will not apply since the ionosphere cannot reliably reflect high angle signals on frequencies above around 10Mhz or less. If forced to use VHF radios for urban combat there is yet one more thing we can do. Many units are now receiving the COM-201 free standing 30-88Mhz antennas that replace their old OE-254 bi-conical antenna. The COM-201 is an excellent 30-88Mhz vertical ground plane extended range antenna with a low takeoff angle and excellent performance characteristics (see *Army Communicator* Summer 2001). The antenna is designed to be lightweight, easy to move, and to stand on its own integral tripod/ ground plane. Due to this construction, it is a balanced antenna and therefore more efficient than any man-pack whip etc. The COM-201 can be brought forward and setup on the ground near to where C2 Headquarters are operating or even inside buildings. The combination of high antenna efficiency and low takeoff angle and the use of the lowest possible operational frequency will greatly improve the signal penetration probability for VHF surface wave transmissions. The COM-201 (see Fig. 9) can be connected to any 30-88Mhz radios in the inventory and because of its performance and portability is virtually the only thing in the VHF inventory that can improve standard VHF radio equipment operations in the urban environment. Unit Signal officers need to be aware of this antenna when only VHF radio is available to support units in urban combat.

Tactical communications using CNR in the urban environment is a hard but not impossible mission for small unit Signal officers. A little basic knowledge about current equipment capabilities and the critical factors of antenna and frequency selection will reduce the difficulty of urban combat communications to a much more manageable task.

To smooth this bump in our professional roads the smart unit Signal officer needs to learn a little, hopefully by reading this article (and other publications) and experiment a lot. Drag out those HF radios and antennas. Even the older ones that don't have all the capabilities of the AN/PRC-150.

Try different antennas, power levels and frequencies etc. until you find the combination of things that work in your situation before you have to do it for real. The same goes for the VHF radios you have. Don't wait to go to the NTC, JRTC or the MOUNT site. The barracks and cantonment areas of major army bases are fine for getting ready to communicate in urban combat. They are just like cities and towns anywhere in the world. National Guard units have it even easier, in many cases all they have to do is get out of the armory and into the neighborhood! The Signal Center also needs to get in gear! Current doctrine, training materials and POIs on how to use CNR in urban-combat just don't have the detail required. Documented requirements for urban combat specific equipment don't exist either as far as we can tell. With the prospects of large-scale urban combat looming larger every day and the reality of Operation Iraqi Freedom with us now, we need to act!

Mr. Fiedler – a retired Signal Corps lieutenant colonel – is an engineer and project director at the project manager for tactical-radio communications systems, Fort Monmouth. Past assignments include service with Army avionics, electronic warfare, combat-surveillance and target-acquisition laboratories, Army Communications Systems Agency, PM for mobile-subscriber equipment, PM-SINCGARS and PM for All-Source Analysis System. He's also served as assistant PM, field-office chief and director of integration for the Joint Tactical Fusion Program, a field-operating agency of the deputy chief of staff for operations. Fiedler has served in Army, Army Reserve and Army National Guard Signal, infantry and armor units and as a DA civilian engineer since 1971. He holds degrees in both physics and engineering and a master's degree in industrial management. He is the author of many articles in the fields of combat communications and electronic warfare.

Mr. Farmer is a Vietnam-era Signal soldier and former lieutenant colonel in California's State Military Reserve, where he ran intrastate emergency communications. He's a graduate of USMC Command and Staff college. He's a professional engineer, has an extra-class Amateur Radio license and is president of EFA Technologies, Inc., in Sacramento, Calif. He has a bachelor's degree in electrical engineering and a masters in physics, both from California State University. He has published three books and more than 40 articles, holds four U.S. Patents and is a frequent guest speaker at communications and antenna-oriented conferences.

Acronym QuickScan

ARQ – automatic request for re-transmission
CNR – combat net radio
COTS – commercial-off-the-shelf
CP – command post
db – decibels
DSP – digital signal processing
JTRC – Joint Readiness Training Center
LDV – Last Ditch Voice
LOS – line-of-sight
MELP – Mixed Excitation Linear Prediction
MOUT – Military Operations on Urban Terrain
NTC – National Training Center
NVIS – Near Vertical Incident Skywave
PL – path loss
OIF – Operation Iraqi Freedom
RF – radio frequency
SINCGARS – single-channeled ground-to-air radio system
S/N – signal to noise
TOC – tactical operations center
UHF – ultra high frequency
VHF – very high frequency