W7MNW
Mercury Northwest

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Inside this issue:

Fill the Shoes and Step up to the Plate

By Ignatius J. Riley

It could be said that on February 12th, Mercury Northwest itself suffered a massive, coronary attack. While many have given much of their time and talents in support of MARA and MNW, Mel Martin, N7BCY (SK), perhaps more than anyone, was the heart and soul.

I know he was instrumental, along with some others in the original organization of MARA Northwest back in the early 1980's, after the Teton, Idaho dam failure and after the Mt St Helens eruption. He was also involved in some of the Mt St Helens amateur radio support operations, including manning the Johnson Ridge area where a radio amateur was lost right after he announced the beginning of the main eruption.

Mel Martin, N7BCY (SK)
March 7, 1944—February 13, 2009

Back in about 2004, after Mel had relocated to eastern Washington, I found myself having dinner with him and his wife, Lauren, in Ellensburg. We had attended one of the annual MARA gatherings at the Kent Storehouse and were heading back to our respective homes, driving only a few miles apart on Interstate 90, talking most of the time on 2 meters.

A few weeks later, Mel, Even Jensen KI7JW (SK), Scott Grimmett, AK7KV – the Spokane Storehouse Area Emergency Communications Specialist, and three others sat around a table and launched the efforts that got amateur radio moving in support of the Church in the area served by the Spokane Storehouse. Since that time, we have something over 200 licensed Church members in eastern Washington, north Idaho, and areas a little beyond.

Having seen the pendulum of amateur radio com-

(Continued on page 2)

The Presidents Corner

by Hollis Kiger W7UFM

I sure wish that Mel was writing an article for the newsletter instead of me. As a lot of you do not really know me I had better give an introduction.

Church activity: I joined the church in San Francisco in 1958 while attending Navy Electronics School on Treasure Island.

Church callings: Ward Genealogy committee 1st councilor, later President, Scoutmaster 3 times, Ward Sunday School 1st councilor, then President (This was in the days before block meetings) Stake Sunday School 1st councilor, Stake assistant Clerk, Stake Young Men's Presi-

(Continued on page 3)

Mercury Northwest RCWG

Jon Mitchell, KD7FAU
RCWG Project Manager

Mission Statement:
"The objective of the RCWG is to develop a reliable 24/7 regional emergency communications system that is relatively easy to operate, will work in a major disaster, does not require a huge outlay of funds, and as much as possible, is not dependent on specific people to make the system work."

For those of us familiar

(Continued on page 4)

Fill the Shoes….

(Continued from page 1)

munications in the Church swing back and forth a few times, Mel had a vision of the Church's emergency communications needs along with a complementary organization of LDS radio amateurs with no official connection to the Church, but dedicated to assisting amateur radio operators so they could be prepared to serve and support Church emergency communication needs when needed. He envisioned an organization that would provide camaraderie, training, participation in amateur radio activities, establishing repeaters, pursuing digital technology, and standardizing some procedures. Mel was the force that resulted in the reestablishment of this newsletter, the various reflectors MNW has, and the regional working group that is investigating the use of six meters as a potential emergency backbone along with the use of low signal modes such as PSK31 and Olivia. Unfortunately, many newcomers did not have as much experience and from their perspective misunderstood and never truly caught the big picture and vision. Nevertheless, Mel continued his efforts undaunted.

While there currently is much happening under official Church auspices in emergency communications, there are some things in the development and training of amateur radio operators that goes beyond the scope of official Church programs. For a number of reasons, (some legal, others practical common sense, and simple scope and propriety) these things are best done in some other type of reorganization. What better than one that totally supports Church standards and can bring LDS hams together over boundaries and areas where the Church has no comparable organization? That was Mel's vision for Mercury Northwest.

Though gone from this sphere of existence, Mel is not forgotten. And we can continue to make sure that is the case. A core group of operators with HF privileges have been MARA Northwest and Mercury Northwest for decades. The area they reside in covers Oregon, Washington, north Idaho, British Columbia, Alberta, and fringe areas in Montana, Idaho, Nevada, northern California, Wyoming, and northern Utah. With linked repeaters and church growth, it is time to bring together this organization of seasoned HF operators with those hundreds of technician class licensees in this same geographical area. Lessons learned from recent disasters, including Hurricane Katrina and the southern California fires, include the high likelihood that LDS hams in the area of the disaster are often impacted and unable to support the local stake or area emergency communications plans. Emergency communications support has to come from LDS hams from outside of the disaster area. Little if anything currently brings LDS hams together on a regular basis from such a broad geographical area like MNW can. And MNW is probably the most expeditious means that they can be mustered into emergency service for the Church and others when needed.

I think that Mel's spirit and vision do and will continue to live on. We finally have the numbers in LDS amateur radio operators, but it is time for the next generation of LDS operators to step up to the plate and fill the shoes left empty by Mel, and others.

Mercury Memos

By John Swapp K7CXJ

This document expresses my opinion and your ideas may differ. We appreciate any discussion that may arise.

CLARIFICATION BETWEEN EMERGENCY RESPONSE COMMUNICATIONS (ERC) AND MERCURY NORTHWEST (MNW)

We are very excited to have so many new hams in the church and most of them are coming in because of the ERC program. Many of those new operators have a vague idea of what MNW is and why. There is a sense that the two activities are redundant and MNW is superfluous. That is not true.

The purpose of this paper is to explain the difference between the two programs.

ERC: Emergency Response Communications is part of the various types of Emergency Response by the Church Welfare Program. The radio traffic will consist of information sent between Bishops, Stake Presidents, Bishop's Storehouses and Church HQ. This is where church leaders will request Welfare Department response. For us in the Northwest, the Storehouse in Hermiston, OR is a "spearhead unit" meaning that they have eighteen-wheelers ready to respond. ERC is an official church program and why "callings" by your Bishop or Stake President to serve in ERC is appropriate.

MNW: Mercury Northwest is a radio club whose membership primarily made of church members. The main purpose for MNW is for sending Health and Welfare traffic from church member to church member or to other individuals. For example, if there is a major earthquake in Reno and your son and family live there, you can send a message via radio to inquire about

(Continued on page 6)

The President's Corner

(Continued from page 1)

dency 2nd Councilor alternate High Council at the same time, Branch Executive Secretary, Branch High Priest Group Leader, Branch Presidency 1st Councilor 4 times (at present time still in this calling) Temple Ordnance Worker for 2 years, Region Emergency Communications, Stake Emergency Communications 2 times, (still in this calling and also on Stake Emergency Preparation Committee).

Ham Radio: Licensed 1953 Novice and Tec WN7UFM. Later passed 13 wpm code and became General Class. In later years to Advanced and then Extra. Mostly to help with VE testing. Have W.A.S, W.A.C. and DXCC running 100 watts SSB. Also have all of them on QRP 5 watts or less SSB.

MARA and Church Communications: Involved since the early 80's

Work: Growing up did farm work. After high school went in the Navy for 4 years. Electronics Tech. The posters say join the Navy and see the world. I only saw California even though I was assigned to two different ships. After discharge we moved back to the Klamath Falls area where I have lived all my life. (except for the Navy years) Got into the Electrician trade. Helped wire homes and some commercial buildings for 4 years as an apprentice. One fall the work was slow so went to Weyerhaeuser Timber Co. as an Electrician for the winter. 33 winter later I retired. That was about 10 years ago.

Family: Met Lois Lowry in the L.A. area. We were married in the L.A. Temple. 4 children 3 boys and a girl. Lois is N7SOV One son Ken is KA7ZRP. Daughter Remi is KA7TFG. 13 grandkids and 2 great grand sons. We will celebrate 50 years of marriage this Sept.

Volunteer work: Scout Council Commissioner, District Cub Roundtable Commissioner, District Cub Leader Trainer, Scout Roundtable Commissioner, Scout Leader Trainer.

Speaking of volunteers I would refer you to Mel's article in the last newsletter titled *Mormons Do Not Volunteer*. We are short of leaders in the Mercury Northwest. Any Takers?

RCWG

(Continued from page 2)

with the erratic and sometimes just plain terrible band conditions on 80 and 40 meters comes the need for something better. The search for more reliable regional communications in preparing for an emergency.

As a test group that's why we are here.

With the recent passing of Mel Martin comes a real void in our group. Mel was always positive about our testing and after months of waiting had just ordered a new radio and digital interface. He was looking forward to using 6 meters and trying out the new digital modes. Mel was wanting to find out for himself how reliable digital communications could be on the HF bands and was preparing to set up schedules with other MNW members. As all of us know, Mel would have insisted that we continue with our testing and see this project through.

Over the past several months the work group has been testing simplex communications on 2 and 6 meters, with an emphasis on 6 meters. Members experienced in emergency traffic handling report very crowded band conditions on 2 meters in and near the larger cities during actual emergencies, both on simplex and repeater frequencies. This is one of the reasons that 6 meter simplex is being so closely looked at. The 6 meter band offers plenty of elbow room and has an edge on 2 meters for contacts over varied terrain using comparable antennas. We have found this edge does drop though as we compare 2 and 6 meters when we need to reach extended distances with beam antennas, noting the need for impractical boom lengths on 6. Other factors yet to be fully explored on 2 and 6 meter simplex/SSB would include the effects of natural and man-made interference. Conditions of course will vary with each individual station.

Months of testing between KD7FAU and KD7ZCM were conducted using 2 and 6 meters where our challenge was to overcome a mountain range that stood between us. The KD7FAU signal had to travel up and over 3,000 feet of hill, then down the other side another 2,000 feet. Several different digital modes and antennas were used with power levels not exceeding 50 watts. Much was learned about signal paths between the two stations which could be applied to other paths as well. Beginning with modest omnidirectional antennas, progressing to high gain beams; we came to rely upon the latter for solid communications regardless of band conditions and local interference during the testing period. Interestingly enough we found that solid communications was had using only 5 watts and the PSK 31 and Olivia modes. Mobile testing was conducted as well with encouraging and surprising results. For all of our testing with beam antenna's, modest power (50 watts or less) and SSB/digital, we found that the old saying, "You never know unless you try," to hold true.

Much of the recent 6 meter testing has taken place in Western Oregon and Washington where the majority of participating members are located and can reach each other with simple omnidirectional antennas. RCWG members on the east side of the Cascades are fewer in number and have longer distances to overcome (up to 200 miles). These distances will require high gain antennas, and likely digital modes, higher power, going portable with elevated transmit sites, or a combination of all. The same will hold true as we continue to look for a way east and west through the Cascades.

As with any radio project, few things can be as important as a good antenna and this topic has been of particular interest to all. Several in the group have started off with all-band antennas, noting poor performance on 6 and even 2 meters. AA7L points out that these types of antenna's can be very inefficient. Dick, K7KFM from Chehalis is building a J-pole for 6 meters. He noted that his current antenna is a dipole which is vertically polarized. He reported that a vertically polarized 100 watt signal from less than 30 miles away couldn't be heard at his location. Others in the group have found the dramatic difference in signals,

(Continued on page 5)

RCWG

(Continued from page 4)

to no signal at all when trying to communicate with stations using opposing polarized signals, it just doesn't work. So the push with our current testing from fixed and mobile stations is with vertically polarized antennas. The J-pole should be a great example and we would encourage those with 6 meter radios to build one.

These first few months of testing have taken place for the most part from member homes using fixed antennas. Dave, AA7L has also taken to the road with 6 meters, leaving his radio and voice activated recorder on at home while transmitting during his travels and very busy schedule. As he would drive along he would transmit from different locations and not have to rely upon another manned station.

A detailed map of the Mercury Northwest region is now on my wall at home. As the different members report their simplex contacts I will note them on the map. This map will be displayed during the May 15th MNW conference where everyone can see just where we are.

In early February, Mel wanted us to push our testing phase to demonstrate possible east/west links by conference time. Anyone with 2 or 6 meter equipment interested in trying to establish this link, and others, are welcome to join us in testing. Our success with this project will take the efforts of several. The main focus with anyone wanting to help would be in constructing an antenna with gain, and for most, the higher the gain the better. When building your antenna, consider a portable design, complete with portable mast that could be quickly set up in different locations.

We would also like to hear from MNW members that are active in 2 meter FM simplex nets. Your coverage area is of great interest and would help us in our region wide coverage data. Information needed would include station locations, what types of antennas were used and power levels.

ERC Conference Lake Oswego 15 Nov 2008

Report by Doug Reneer WA7UAH

He's a church service missionary and not a church employee. His mission is church emergency communications and he's been doing it for years.

Philosophy: What form of emergency communications will serve church leaders?

Go to "provident living" then to Emrg Comms.

Reduces directive to simple policy that applies to any stake in the world.

Stake should not buy gear. Problems in keeping it secure and maintaining it.

Reliable comms:

1. Simplicity
2. Redundancy – 2nd device
3. Diversity. SSB, FM, digital
4. Have ownership of the system. Don't rely on someone else.

Guidelines for preparation and response:

1. Preparation
2. Response
3. Recovery is where most church activity takes place.
4. Mitigation. Reduce effects of future events.

Call it a <u>response</u> plan. Have it with me at all times. Put it on one sheet.

Terminology is Emergency Communications Specialist (ECS).

Activities for the ECS:

1. What will work?
2. Establish relationship with church leaders.
3. Become familiar with church policy.
4. What flow of information is expected between church and civil

(Continued on page 6)

ERC Conference

(Continued from page 5)

authorities?

5. Emerg Comms Plan…get Stake President to approve.
6. Must be able to operate without commercial power and under adverse conditions.
7. Develop cadre of operaors that can be called on after their family is cared for. 65 percent of hospital staff leave to care for their family.
8. Emerg kit of comms eqp to last three days.
9. Respond to neighboring stakes and the community.
10. Conduct exercises regularly.
11. Familiarize and orient church leaders.
12. Continue to seek knowledge. More proficient. More capability.
13. Seek guidance from the Lord and from church leaders.

HTs of very little value in Katrina due to rubber duckie antenna.

Study FEMA and ARRL courses.

No simulated emergency scenarios transmitted due to liability concerns of public monitoring. Continue comms exercise but no SET.

Terminology is Stake ECS and Ward ECS.

Three ways to get stake report and request for response out of Bellevue:

1. **Ham Radio to Kent Storehouse**
2. **Ham Radio from stake ham directly to church HQ via ERC HF.**
3. **Radio contact with any ham, anywhere, who can make a telephone call to church HQ using the toll free 800 number. These operators at HQ are well trained and are ready 24/7. They will call Utah hams to get on HF freq.**

Estimate 300 people attended. Larry Stanley VE7AMK came from as far away as Vanderhoof, BC 500 miles north of Vancouver, BC. Larry is a member of the Mercury Northwest Net.

HF radio is under utilized. NVIS antenna is a good choice.

Hams responding to a disaster location should have good credentials or ID issued by local government or ARES. Ham radio license plates on vehicle may not be enough.

Mercury Memos

(Continued from page 3)

their well being if you have no other way to communicate with them.

There are some locations where a scheduled ERC net and a scheduled MNW net have the same primary frequency listed for their net. When a disaster occurs, operators should be aware that ERC nets and MNW nets can be, and probably will be, active on the same frequency. All hands should remember that ERC traffic takes precedence over MNW traffic. If an operator has traffic to pass, it should be announced as to which type of message. For example, "This is K7CXJ. I have one Health and Welfare message for Reno". This allows the Net Control Station (NCS) to handle the traffic according to precedence. This situation emphasizes the importance of secondary frequencies for all nets.

I sincerely hope that church hams can see the importance of both programs and will want to participate in both programs. I appreciate any further discussion of this topic.

Please see www.mercurynorthwest.org

Editors Note

By R.B. Sturtevant AD7IL

There has been a lot of loose talk and inaccurate information about NVIS antennas since I first started talking about them on the nets. One thing I would like to make clear is that an NVIS is nothing more than a standard dipole antenna in an inverted V configuration. Communications between two NIVS or two dipoles or one of each should be about the same except at short range. The whole NVIS concept was developed by the Military during World War II. The Germans seem to have developed it first but the Brits developed the same idea independently. In fact it was top secret on both sides until about the time of D-Day after which it was still circulated only in classified manuals.

We all know about the skip zone that exists between the end of our ground wave signal and the point where our signal bounces off the ionosphere and hit's the ground again. The NVIS is designed to reduce or eliminate that skip zone.

To further clarify the NVIS phenomenon I've found this article that may help us all understand this type of antenna and how it can help us all with short-range HF.

What is NVIS?

by Harold Melton, KV5R
From the Athens Amateur Radio Club Web Site

Near-Vertical Incident Skywave is a combination of radio hardware, skywave radio propagation, operating procedures, cooperation, and knowledge used by a group of radio operators who need reliable regional communications. It fills the gap between line-of-sight groundwave and long-distance "skip" skywave communications.

German ground forces first documented NVIS techniques in WW-II. NVIS was more fully documented, studied, and used by US forces in Vietnam. Radiomen in military vehicles discovered that their HF whips would sometimes work much better when tied down horizontally. Amateur radio operators have been studying NVIS propagation and operating techniques for at least fifteen years. In tactical military use, NVIS allows communications around the region while providing very little groundwave signal for the enemy to home in on. Any radio operator that has used a horizontal antenna well under a half-wave high has used NVIS.

NVIS propagation is generally considered to be F-layer ionospheric reflection at angles of 70-90 degrees. It is skywave propagation without the usual skip zone. The purpose of NVIS is to communicate locally and regionally, out to a few hundred miles, with moderate power, simple antennas, and no skip zone. NVIS is typically used on 160, 80/75, 60, and 40-meter bands by Amateur radio operators using relatively low horizontal wire dipole antennas. NVIS operations are optimized by understanding and controlling two major factors: (1) Proper antenna design and placement, and (2) proper training of the operators. The antenna is designed and placed to provide the maximum possible gain straight up, on two or three frequency bands. Operator training includes an understanding of antennas, ionospheric propagation, and operational procedures.

NVIS Propagation

When a horizontal dipole is 1/2-wave high, it has a wide null overhead, and a main signal radiation pattern shaped like an inverted cone. The reflected wave from the ground is out of phase with the antenna and so causes partial phase cancellation overhead. This makes a good "DX" antenna, with gain at relatively low angles, and a wide skip zone. Problems arise, however, on regional nets and rag chews, because of the skip zone.

As the dipole is lowered

(Continued on page 8)

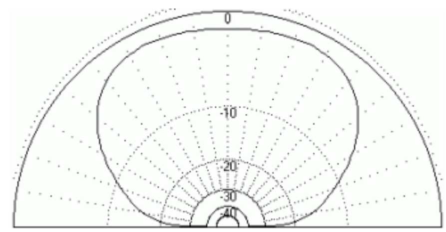
What is NVIS?

(Continued from page 7)

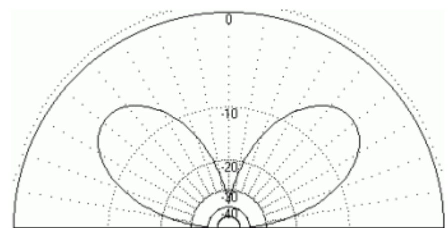
below a half-wave high, this inverted cone closes up, the overhead null disappears, and most of the power is radiated upward in a wide lobe shaped like an egg. The reflected wave from the ground is closer to being in-phase with the antenna, increasing the amplitude of the vertical-angle RF power. The effect is somewhat like a 2-element yagi pointing straight up. At a height of .15 to .2 wave, over excellent ground, gain can approach 7 dbi, straight up. Imagine pointing a powerful searchlight straight up at a cloud: The resulting bright spot would provide indirect lighting for miles around! With a horizontal antenna suspended well under a half-wavelength high, we achieve the same effect. We deliberately illuminate the F-layer (which varies from about 100 to 300 miles up) with a wide RF flood, which causes indirect RF illumination of the whole region.

The following graphs show typical elevation profiles for a 75 meter horizontal dipole at various heights. It is apparent that the best NVIS coverage may be obtained at about 3/8ths-wave, or 90 feet high. However, this is impractical for most installations, and antennas much lower will perform almost as well, with the main difference being in the fringe area of coverage. Please note the amounts of power available at various angles, for each height represented.

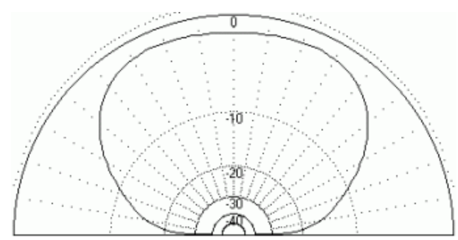
Figures 1a - 1d: Elevation profiles of the 75-meter horizontal dipole, over average ground.



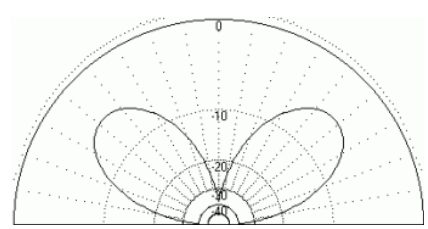
1a: 75-meter NVIS antenna at 90 feet high (3/8ths-wave). The -10db ray is at about 22 degrees, -20db at about 4 degrees, and considerably more power is now available at 30-60 degrees



1b: 75-meter NVIS antenna at 67 feet high (quarter-wave).
The -10db ray is at about 28 degrees.
The -20db ray is at about 6 degrees.



1c: 75-meter NVIS antenna at 90 feet high (3/8ths-wave). The -10db ray is at about 22 degrees, -20db at about 4 degrees, and considerably more power is now available at 30-60 degrees



1d: 75-meter antenna at 125 feet high (half-wave)
No longer NVIS, but now a "skip" antenna,
with most of the power at about 42 degrees.

(These graphs compare closely with the ARRL Antenna Book)

What is NVIS?

(Continued from page 8)

Thus we can see that raising the 75 meter NVIS antenna from 20 feet to 90 feet will add about 8db to the signal ray at 30 degrees, which is considerable, but usually not a sufficient justification for adding two 90-foot supports to the antenna farm. The rule here is pretty simple: If you want a reliable range of, say, 300 miles, use a real low antenna. If you want a little better morning/ evening coverage, go to 90 feet as the optimum height. Raising the antenna from 20' to 90' simply gives you a little more power at lower angles. Part of this extra power comes in part from the top of the lobe, and in part from reduced ground absorption. Best vertical gain (about 7dbi) is achieved at .15 to .2 wave high, but the 20 -foot high antenna will still have a gain of about 5. The best possible SWR may be achieved at about 41 feet, over average ground.

The graphs in Figure 1 do not reflect the whole mechanism involved in daytime 75-meter path length reduction. The next major factor is D-layer absorption, which gradually builds up in the morning after sunrise, and gradually fads away in the late afternoon. Since most of the signal power is at high angles, it continues to penetrate the absorptive D -layer on the way up, reflect off the F2 layer, then penetrate the D-layer again on the way down. At lower angles, the available power is much less, due to ground interaction with the antenna, and the low-angle path suffers additional losses by passing through the D-layer (twice), at lower angles. For example, if the D-layer is 30 miles thick, the high-angle ray will pass through about 30 miles of absorptive D-layer (twice), but the 30-degree ray will pass, at that angle, through 60 miles (twice). (See Figure 2.)

In Figure 2, we observe two of the three mechanisms that combine to attenuate low-angle daytime signals: (1) Compare the radiated power, which is about 2db below peak at 70 degrees, with the 30 degree angle, which is down about 14db. (2) Compare the distance the rays must travel through the absorptive D-Layer (twice) at various angles: the 30 degree ray has about twice as much loss as a very high angle ray. (3) Add the normal attenuation due to path length (not shown). These three factors, plus a little loss in the troposphere, all combine to attenuate low-angle signals in the daytime. As the sun gets higher, D-layer ionization intensifies, and the effective range decreases further.

From late evening to early morning, 75 meters may spread out to 1500 miles or more, as the D-layer disappears and absorption is no longer a factor in path losses. The typical NVIS antenna pattern shows the signal power at 20 degrees is down 20db, so it is more likely that 1000-2000 mile contacts are made not by the -20db single-hop ray, but two or even multiple hops from the much more powerful rays available at the higher angles. Another factor in "stretching out the band" is the Pedersen ray hop, a mechanism that may be roughly described as ducting in the F-region of the ionosphere. One unfortunate effect of the band "going long" is that many thunderstorms will exist during the warm months somewhere within that giant coverage area. This leads to a great deal of static noise that tends to render the low bands rather useless in the summer, at night -- particularly for weak-signal contacts.

In the morning, the sun gradually reestablishes D-layer ionization. It starts absorbing signal power like a giant blanket of attenuation, and its effect increases steadily (more or less) as the sun gets higher. With the NVIS antenna, the low angles where RF power is lowest will become useless out at some point, and the practical signal path distance will draw in to two to three hundred miles radius by mid-to-late morning.

This is because most of the signal power is at high angles, and only the main

(Continued on page 10)

What is NVIS?

(Continued from page 9)

lobe of the antenna is powerful enough to penetrate the D-layer twice. By late-morning (typically), signals beyond 150-200 miles usually become very weak, then inaudible. Raising both antennas substantially (to 125 feet) would provide more power at lower angles and thus increase the range and/or time available, but this is usually quite impractical. The practical solution is to switch to 40 meters, where D-layer absorption is much less and the antenna is twice as high in terms of wavelength. Switching to 20 meters will give nationwide coverage, but with a wide skip zone, assuming the F2-layer is undisturbed. Amateurs, shortwave broadcasters, military, maritime, and aviation stations regularly switch frequencies with the day-night cycle, to maximize reliable signal levels at a given distance.

Of course, the "numbers" are widely variable, depending on prevailing ionospheric conditions and the environment of the antenna, particularly ground conductivity. The "numbers" are roughly based on carefully logged US Army tests, where they compiled the percentage of messages accurately passed, for various frequencies at various times of the day and night, and generated frequency-time charts There are occasionally exceptions, but this article is concerned with reliable tactical communications, not occasional exceptions caused by unusual, atypical band conditions.

All of this explains why the reliable, effective path length on 75 meters contracts and expands with the day-night cycle.

Another consideration is ground quality, consisting of conductivity and dielectric constant. The power lobes and nulls of an antenna's radiation pattern are created by the distant mixing of the direct and ground-reflected rays, which may be in phase for a lobe, out of phase for a null, and everywhere between for the intermediate levels of power. The ground's conductivity in the immediate vicinity of the antenna affects the feedpoint resistance and degree of power absorption. The ground quality out to several miles will affect the radiation pattern. Excellent quality ground, such as sea water, will provide the best results, while poor quality ground will absorb more power and substantially shift the phase of the reflected ray, greatly reducing power at low angles.

Variations in ground quality from one location to the other explains why one station with a relatively poor antenna may enjoy much better signals, over very good ground, while another station with a highly-optimized antenna may have a relatively poor signal, over poor ground.

Since ground quality is what it is, the operator with very good ground need not go to extra trouble to optimize his installation, while the operator with poor ground should optimize his antenna to the greatest practical extent. Average ground is considered to be 5 milliSiemens per meter (mS/m) and a dielectric constant of 13. The topography of the land in the vicinity of the antenna also affects the pattern. The height above average ground affects the feedpoint resistance as follows:

Meters	Feet	Ohms
4	13	8
6	20	15
8	26	25
10	32	35
12	40	46
14	46	57

Table 1: Feedpoint resistance of a center-fed, resonant half-wave horizontal wire dipole, over average ground.

In Table 1, the dipole was modeled over average ground, at various heights. For each height, the dipole length was optimized to resonance. It is apparent that regular dipoles should be mounted about 41 feet high, if the lowest possible SWR is to be achieved, when feeding with 50-ohm coax. Alternately, a folded dipole may be placed at

(Continued on page 11)

What is NVIS?

(Continued from page 10)

about 16 feet. Since there is a 4:1 transformation with folded dipoles, the feedpoint resistance will be around 50 ohms. The folded dipole will also have considerably broader bandwidth.

A desirable effect of the NVIS vertical lobe is the reduction of received atmospheric static from distant storms (in the daytime), since most atmospheric static comes in from angles below about 15 degrees. Narrowing the vertical beam width of the antenna reduces the noise further. This is accomplished by lowering the antenna until the best signal-to-noise ratio is achieved. Alternately, the antenna may be raised to 0.2-wave and a reflector element installed underneath, on the ground, to create a 2-element yagi thereby narrowing the beam width and increasing the gain. This will improve the s/n ratio further, on sites with poor soil. Experience shows that storms may be heard when they are within the antenna's effective area of coverage, which is much greater at night than in the daytime. When the storms are nearby, no amount of antenna fiddling will improve the static -- but if your contact is at, say, 150 miles, and the storm is at 300 miles, lowering the antenna will certainly improve the signal-to-noise ratio by reducing the effective signal radius to exclude the storm.

The frequency to be used at any particular time is selected to fall between the vertical MUF (the highest frequency that will reflect back down from nearly straight up), and the upper frequency end of severe D-layer absorption. Typically, this is 40 meters in the daytime and 75/80 meters at night. 160 meters may be used in the wee hours, if RF begins to break through the F2 on 75. In actual practice, 75 may be used for regional contacts from about 5 PM to about 9 AM, and 40 meters will carry you through the day from 9 to 5. There are several exceptions worth noting: (1) 75 may be useless at night, in the stormy months, due to high static -- and 160 certainly is. (2) 75 may drop completely out in the wee morning hours due to failure of F-layer reflection. This is when 160 may be employed, assuming the static will allow it. (3) 40 may drop to unusable levels during the day due to solar activity. Other bands will be affected as well.

Another factor to consider is groundwave. If the stations are close enough, the groundwave and skywave will mix in the receiver, and cause multipath distortion, due to the considerable difference in path lengths. For example, for stations 10 miles apart, the groundwave will travel 10 miles, but the skywave will travel 200-300 miles. For this reason, groundwave must be reduced as much as possible. This is done by both stations lowering their antennas to the practical minimum height. This is usually 10-15 feet across open spaces, and 4-6 feet on fences.

Some people operating mobile have noted a small "dead zone" that extends several miles outside of groundwave range. This may have one of two causes, or both. First, the fixed station is running NVIS, but the mobile is running a vertical whip. RF power arriving from directly above the whip cannot induce current into it. This is why military vehicles are instructed in their Field Manuals to tie the whip down. Second, some researchers theorize that the vertical NVIS lobe has a tiny "hole" right at 90 degrees. The reasoning for this is that the up-going wave and the down-coming wave cannot occupy the same space without phase cancellation -- so we might say that there is a "skip zone," albeit a tiny one. The author believes that both of these mechanisms may come into play in certain circumstances.

Why Do It?

First and foremost, to completely eliminate the skip zone. This enhances all forms of local and regional HF communications, for all practical and experimental purposes.

Emergency groups

(Continued on page 12)

What is NVIS?

(Continued from page 11)

such as ARES and RACES are studying NVIS propagation, techniques, and equipment deployment for emergency preparedness. NVIS is the tactical communication system of choice in mountainous areas, any areas without complete repeater coverage, and all situations where repeater-based systems have failed or might fail. With the recent release of manufactured mobile and even portable HF radios, HF, and antennas employing NVIS propagation, should become much more popular and useful for disaster tactical communications.

Researchers and users have observed that NVIS antennas work considerably better in the valley than on the mountain top. This is due to much better ground conductivity in the valley than on the dry, rocky mountain top. This happy fact eliminates a lot of unnecessary climbing, and allows the antenna to utilize trees for both support and cover.

NVIS-equipped Amateur fixed stations enjoy regional nets and rag-chews without the annoying skip zone. It is particularly useful to net controllers and emergency practice groups. All fixed stations should take steps to immediately supplement their antenna farms with at least a dual-band NVIS antenna (described herein).

Antenna and propagation experimentation is FUN! Building and deploying antennas is as close as many hams get to home brewing. NVIS is as easy as antenna experimentation can get. The antennas are simple, and are installed very low. Light-gauge wire and nylon string may be nailed to trees at extension-ladder heights. Dropping a dipole and making a change to it takes only minutes and may easily be done by one person without the need to obtain helpers or plan a big event.

NVIS antennas are stealthy. Communism-by-contract property owner's associations have restricted the placement of visible antennas and severely stifled Amateurs' pleasure, emergency preparedness, experimentation, and innovation. With NVIS, a fine wire may be brought through the trees, or routed along the top of a privacy fence. The Ham thusly equipped may never win any low-band DX awards, but will still have ample opportunities for QSOs and nets within the regional circle provided by an NVIS antenna in the daytime, in addition to some low-band DX at night, particularly in the winter when the storms are gone.

If you could only have one antenna, it should be an NVIS with ladder-line feed and a tuner, as this may be operated on all bands. The "best" multiband antenna is probably the 260-foot dipole, or 520-foot loop, with 76 feet of windowed ladder line and a tuner.

How to Make a Good NVIS Antenna

The best NVIS antenna is one which is simple and effective. One favorite is the dual-band dipole. This antenna uses two dipoles, one for 75 meters (about 122 feet), and one for 40 meters (about 65 feet), both connected directly to 50-ohm coax and supported at 5 points by trees at 10-12 feet. The two dipoles should be well separated at the ends, or they will interact. They may be strung up in an "X" or a "+" shape. The bandwidth of the 75-meter dipole will be quite narrow (<100kc), so it will benefit from using two sets of stagger-tuned wires. Some researchers recommend that the ends of the wires should be a few feet higher than the middle. This will increase gain and raise the feedpoint impedance a bit. If the feedpoint impedance is too low to match, the antenna should be a folded dipole, which will raise the feedpoint impedance by a factor of four. Stringing the antenna over a highly conductive surface, such as salt water or a wet, acidic marsh, will substantially improve the antenna's performance, compared to stringing it over dry rock or sand. Since the support points are typically 10-12 feet high, the wires must be

(Continued on page 13)

What is NVIS?

(Continued from page 12)

both light and pulled tight to remove annoying sag.

Appropriate wire ranges from #17 aluminum electric fence wire, ($14 for 1/4-mile at farm-supply stores), to #14 insulated stranded copper THHN, ($15 for 500 feet rolls at electrical suppliers, and available in green). The #17 aluminum isn't very strong, but is almost invisible. The wire may be supported with green nylon string, available at garden centers. The center feedpoint and coax may be built around a simple insulator, waterproofed, and nailed to a tree trunk at 10 feet.

Insulators and coax may be sprayed dark green or brown as needed. Antennas below 8 feet should use insulated wire to avoid RF burns. Insulation does not affect the performance of antenna wire, except (1) reduced wind and rain static, (2) lowers the velocity factor a tiny bit, and (3) prevents corrosion.

It is better to use a broadband current balun at the feedpoint when using coax. A simple choke balun made of coiled coax may be used if needed to remove common-mode currents from the line. Try to design the installation so the feedline extends away from the antenna at a 90-degree angle, for at least one-quarter wave. Also, the line should be detuned -- that is, it's length should fall between resonance points. If these are done, feedline RF pickup and re-radiation will be minimized, and a balun should not be needed. Detuning the feedline is also the cure for "RF in the shack" problems. Suitable lengths will depend on how the antenna is fed and whether one side is grounded or not. See the Antenna Book for determining appropriate lengths.

For resonant dipoles, avoid using twin-lead or ladder line -- the feedpoint of these low dipoles will be well under 50 ohms and attaching 300-600 ohm parallel feedline will present a severe mismatch at the feedpoint. However, if the antenna is to be used nonresonant, with a tuner, ladder line should be used because coax is very lossy when operated at high VSWR.

There is a long-standing myth that dipoles must be resonant to be efficient. Non-resonant dipoles of similar size are just as efficient as resonant dipoles, assuming that (1) impedance mismatches are matched, (2) the matching devices are designed so that losses are insignificant, and (3) feedline losses are minimized (use ladder line when the SWR is high). It is also important to remember that baluns and matching transformers are quite lossy when operated with a mismatch on either or both ends. The ARRL Antenna Book shows how to make baluns for any ratio of impedance transformation. The myth come from the fact of severe losses in mismatched coaxial line. In the author's experience, a 160-meter dipole fed with ladder line will outperform a 75-meter resonant dipole fed with coax, both at the same height, and both operated on 75 meters. This is because the larger antenna, even though not resonant on 75, has an "aperture" twice as large as the smaller one and thus captures, and radiates, more signal. However, it does have 4 partial nulls, while the half-wave dipole has only two.

To connect aluminum or steel wire to copper, make a couple of short #14 solid copper pigtails, twist them tightly into the aluminum or steel elements at the feedpoint, then solder an SO-239, or direct coax feed, to the copper tails. Waterproof the dissimilar metals connections with waterproof grease and Coax-Seal, or silicone caulk. If any moisture gets into the connection, the metals will corrode one another and make a nasty rectification point. Mechanical connectors (split-bolts or set-screw lugs) may be used but they also should be waterproofed.

Fancier (more expensive) NVIS installations include full-wave loops with automatic antenna tuners at the feedpoint. These antennas, if installed at 15-20 feet or more, will provide both excellent NVIS

(Continued on page 14)

What is NVIS?

(Continued from page 13)

performance on the low bands and DX on the higher bands, where the height of the loop is over 1/2-wave. However, the pattern of the antenna will have several peaks and nulls on frequencies where it is several waves long.

Two things about loops are worth mentioning: (1) Loops are resonant on every harmonic, not just odd harmonics like dipoles, and (2) the lower the frequency (greater the length) of the loop, the more harmonic points it will have. For example, an 75-meter loop will resonate at about 3.8, 7.6, 11.4, 15.2, etc. But a 160-meter loop will resonate at about 1.8, 3.6, 5.4, 7.2, 9.0, 10.8, 12.6, 14.4, etc. -- and the peak SWR arising from imbalanced reactances will be lower between all these points. Therefore, a big loop should be strung up, even if it cannot be used on its fundamental frequency because of low feedpoint impedance.

Carrying this idea further, an operator with acreage might run a really big loop (like 1100 - 2200 feet) atop a perimeter fence and it would have so many resonant points as to be useful as a broadband antenna -- although the fundamental and all harmonics below about 3-4 MHz might be unusable for transmitting due to extremely low feedpoint impedance, unless feedpoint matching is used.

Another good antenna is the 3-wire folded dipole. This design may be used on all HF bands, with a tuner. The rules are pretty simple: Make a 2- or 3-wire folded dipole as long as possible (preferably 260 feet). Feed it directly with ladder line, and match it to the radio with a balanced line tuner. Use a 1:1 current balun at the tuner's input. The reasons: (1) Feedpoint resistance of low antennas will be very low, typically 15 ohms or so, and the 3-wire folded dipole will raise it by a factor of 9. (2) Ladder line does not suffer any significant loss when operated at high line SWR (unlike coax). (3) Balanced tuners with the balun on the input (the matched side) are considerably more efficient than unbalanced tuners with the balun on the output, because baluns are only efficient when both ends are matched.

Some emergency groups are successfully experimenting with mobile antennas mounted horizontally. For example, pairs of 75 and 40 meter Hamsticks make excellent shortened, portable NVIS dipoles. The mobile antennas are mounted back-to-back and fed in the center just like a dipole. These are oriented horizontally and placed a couple feet above the roof of a vehicle on a short mast.

Other operators carry (1) an autocoupler, (2) a 125' roll of wire, and (3) traffic cones or fiberglass stakes in the trunk, for rapid roadside NVIS deployment. NVIS antennas have been used as low as 18 inches high. Surprisingly, S9 signals have been received from an antenna mounted 10-1/2 inches high.

Preparing for Portable NVIS Operation

Emergency communication groups should create and test an "NVIS kit" which contains a sturdy NVIS antenna, feedline, tuner, and sundry tools, hardware, and accessories. The radio should be a small, "all-band" rig like the Icom IC-706, powered by a deep -cycle battery. Hardware should include a 20-30 foot telescopic pole, #18 nylon line, stakes, throwing weights, hammer and nails, extra feedline and connectors, etc. Tools should include the usual electronics hand tools, including a small butane soldering torch and extra butane fuel. Accessories should include a folding table and chair, a rain tarp with it's lines, and an ice chest with food and drink. Another piece of hardware worth having is the notebook computer, with appropriate software and cables, that may be used to provide radio teletype traffic. The station should also include a 2-meter transceiver and antenna, and a scanner.

The entire station may be packed in a medium-sized ice chest, using custom-cut

(Continued on page 15)

What is NVIS?

(Continued from page 14)
foam rubber for the sensitive parts. The serious portable operator will also have a tent and various other camping equipment and supplies. Some clubs even purchase and equip a small travel trailer for this purpose. This is the best solution, since the trailer will contain all the needed equipment and supplies, at the ready, and will also provide a measure of security and protection from the elements.
Don't have just one NVIS antenna. Have one at home (a dual-dipole, or multiband nonresonant, or a loop), and have another for fast portable deployment.

The portable antenna and its feedline may be rolled up on an extension cord reel. You never know when you may be needed to quickly deploy a portable station. The goal should be to prepare to provide reliable regional tactical communications services without power mains, in the midst of large-scale emergency events. It's also a good idea to have the radio "clipped" so that it may be operated outside the ham bands by emergency officials who are authorized to do so. The station will usually need to be located at the incident command post -- however, it is very important to make prior arrangements with the authorities.

Tuners: The best tuner for barefoot NVIS is probably something like the MFJ 949E. It has a wide tuning range, internal balun with balanced output, three-position antenna switch, internal dummy load, and a large cross-needle meter. Of course, full power tuners must be used with linear amplifiers. Autocouplers by SGC and others work very well at the feedpoint, provided the impedance isn't too low. The internal autotuners in most radios usually do not have sufficient range to match low antennas on 160. The 75/40 dual-dipole described above does not need a tuner, as the elements may easily be adjusted to resonance. If the SWR at resonance is still too high, raise the antenna a few feet, because the feedpoint radiation resistance is probably too low. Modeling over average ground shows a feedpoint resistance of 50 ohms at around 41 feet high. Short stubs with alligator clips may be clipped onto the elements at various places to provide multiple resonant points, and if bare wire is used for the antenna elements, these may be moved around to match the antenna (don't burn your fingers).

Power Supplies: The portable station should use a deep-cycle marine battery and a portable generator. Small "camping" generators in the 900 to 1800-watt range, having both 13.8 VDC and 120 VAC outputs, are the most preferable. Connections to batteries should be made using ring lugs soldered to the wire, attached to the battery with stainless steel bolts, washers, and wing nuts. All connections should be greased. The battery should be connected to a power distribution box, of the type with several sets of 5-way binding posts.

How to Work NVIS into Tactical Emergency Communications

NVIS is not just an antenna type or a propagation mode -- it is a tactical communications system that was designed by military radio operators in the field. The NVIS antenna is only part of that system. The other part is the knowledge and cooperation of the operators, which must be accurately applied to achieve the best results -- particularly when results are a life-and-death matter. Emergency communications should be driven by clearly written procedures that have been well-designed and tested. The procedures should be drilled on a regular schedule, and the drills should be followed by debriefings attended by everyone, so that all can learn to avoid mistakes. Suitable procedures are available in books, Field Manuals, and on the web. Look for ARES and RACES web sites and capture their procedural documents. Other excellent sources are FEMA and MARS sites.

(Continued on page 16)

What is NVIS?

(Continued from page 15)

Groups of operators using NVIS must understand and cooperate on the basics. (1) All must be using NVIS antennas (defined as any horizontal antenna well under a quarter-wave high), as well as the radio hardware and propagation theory. (2) All must understand that the frequencies used must stay between the total absorption and vertical MUF ranges. (3) The group must decide whether it will equip itself to use 160. (4) Calling frequencies and other procedures should be established, in writing, with contingencies clearly stated.
For example:
1. Meet at 7228 before 8 PM summer, 6 PM winter.
2. Meet at 3853 after 8 PM summer, 6 PM winter.
3. If the frequency is occupied: Move UP 2 kc and listen or call, for two minutes.
4. If occupied, move UP 2 kc MORE and listen or call two minutes, etc.
5. When QSYing to another band, if no contact made in 6 minutes, return to previous frequency.

This procedure helps to keep people from getting lost and scattered on the dial. It's a good idea to keep assigned frequencies in VFO A and B, or use radio memories.

In the evening, 40 will spread out and suffer interference from foreign broadcast stations, and later, show signs of fading as the vertical signal starts breaking through the diminishing F layer. Before the operator is lost in the noise, QSY to 75 meters. In the mid-morning, as the absorption rises and kills off 75, QSY to 40. The 60-meter band should provide a much-needed transition frequency -- but, alas, the government has limited it to 50 watts EIRP and five discreet channels...

The signals for every NVIS operator within 200-300 miles, running 100 watts, should be well over S9. If you hear a very faint station and want to work it, switch to a higher dipole or a higher frequency.

Running high power is usually not needed. QRO will greatly increase your groundwave radius, and thus, the number of possible stations which will receive multipath distortion. High power may be needed to overcome QRM or QRN. Otherwise, keep the power down, keep the groundwave close in, and let F2 do the work. If already getting out an S9+10, why QRO and make it a +20? It you can't get above the static, lower your antenna and tell your field contacts to do the same. If you can't get the distance you need, switch to a much higher antenna with a lower angle of radiation, or QSY to a higher band.

Interesting "Rules of Thumb" based on tests on the 40 meter band (from WA6UBE):

Returning briefly to the "What's the best NVIS height?" question, observe the excellent research of Patricia Gibbons:
"Assume a half-wave dipole at 1/4 wavelength above ground as a reference for comparison: A half-wave dipole at 6 to 7 feet off the ground will have an attenuation of approximately -4 dB. A half-wave dipole 10-1/2 inches over lossy ground will have a worst-case attenuation of approximately 20 dB."

"Assuming correct choice of frequency and a 10.7 cm solar flux value in the 200 range, a half-wave dipole at 1/4 wavelength above the ground would provide a 20 dB over S9 signal reading at the distant station when the transmitter has a power output of 100 Watts. If the transmitting station uses an antenna at 6-feet above ground-level, the resultant signal strength would be: 16 dB over S9. If the transmitting station uses an antenna at 10-1/2 inches above the ground, the resultant signal strength would still be S9!"

Links to More NVIS Study

This article:
http://www.athensarc.org/nvis.asp
(and see also other articles at www.athensarc.org/techindex.asp)

A great introductory article:
http://www.qsl.net/wb5ude/nvis/index.html

(Continued on page 17)

What is NVIS?

(Continued from page 16)

The excellent site of NVIS guru Patricia Gibbons, WA6UBE:
http://www.tactical-link.com
http://www.tactical-link.com/nvis_member_page.htm
http://www.tactical-link.com/field_deployed_nvis.htm -- lots of tests and photos

Field Manual 24-18 Appendix M -- Lots of info and graphics (now on this site!)
http://www.athensarc.org/fm2418m.asp

Army Manual TM 11-5985-379-14&P for the AS2259/GR Military NVIS Antenna -
See esp. Section 3 (p.25) for lots of easy NVIS theory. Note: 78 pages, takes a while to load!
http://www.co.missoula.mt.us/acs/documents/TM%20NVIS%20antenna.pdf

Northern California RACES NVIS experiments:
http://www.sedata.net/nvis.html

Antenna Guru L.B. Cebik's Notes on "Cloud Burners:"
http://www.cebik.com/wire/cb.html

Search Usenet groups for NVIS (hundreds of postings by NVIS experimenters):
http://groups.google.com/groups?q=nvis&ie=UTF-8&oe=UTF-8&hl=en

The NVIS discussion group on Yahoo Groups (350+ members):
http://groups.yahoo.com/group/nvis/

TELEX military NVIS antenna (the AS-2259/GR):
http://www.telexwireless.com/MilitaryAntennas/Product.aspx?MarketID=9&CategoryID=8&ProductID=58

The MINIBAC antenna system and the neat web site of Bonnie Crystal, KQ6XA:
http://www.qsl.net/kq6xa/antenna/

The HF Portable Group:
http://www.hfpack.com/

Technical background:
http://www.fas.org/spp/military/docops/afwa/U2.htm

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Here is Some More Help From Our Friends

By Donn Hilton VA7DH

Have you ever ordered something or sent a radio out for repair and had it come back packed in Styrofoam popcorn chips? What do you do with it? I pack it up into plastic shopping bags. The problem is that it really fights going into a bag, static electricity is keeping it from going where you want it to go. There are two things you can use. One is an anti static spray women use to spray their synthetic clothing. Back when I had a CRT type computer monitor I would use a moist cloth to clean the screen and then spray the screen with anti static spray and it took much longer to coat up with dust.

In the case of the Styrofoam packing you spray the packing and also spray the inside of the bag you want to put the chips into. A cheaper alternative that works just as well is Windex spray. In either case the static charges get shorted out and become neutral. The chips go where you want them to. Sanity is restored. All is well.